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Module 4: Disease Defenses

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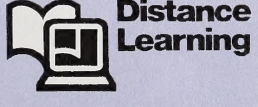
Science 24

Module 4

DISEASE DEFENSES



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Student Module
Module 4
Disease Defenses
Alberta Distance Learning Centre
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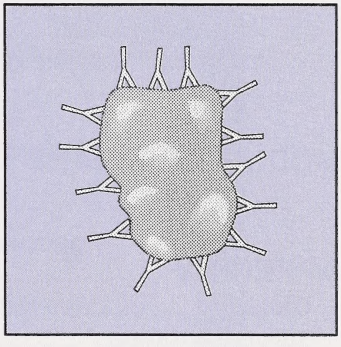

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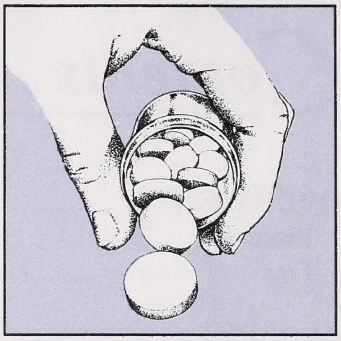

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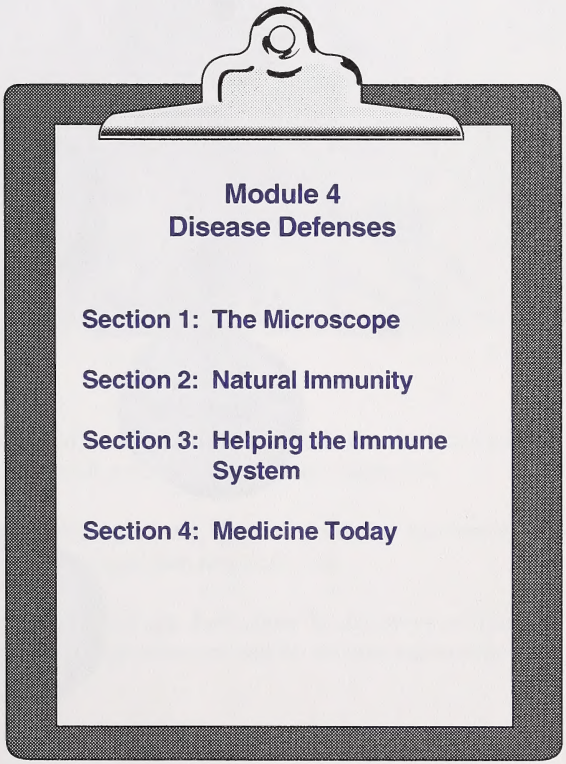
OVERVIEW

Were you ever sick with measles, mumps, or chickenpox when you were a child? At the time you may have felt like you wouldn't recover, but in no time you were feeling fine again.

A long time ago some of the more common sicknesses may have been life-threatening, but now with proper food, rest, and medicine these diseases can be controlled. There are still diseases, such as AIDS, for which medical technology has not yet found a cure. However, some diseases, such as diabetes, do have forms of treatment which do not cure the disease but make it more bearable.

In this module you will learn how your body and medical technology work together to defend you from diseases. You will learn about the discovery and types of the microscope. You will discover how the microscope led to the exploration of an unseen microscopic world. You will become aware how your body is equipped to fight disease. Finally, you will realize how medical technology has been fighting and continues to fight disease.

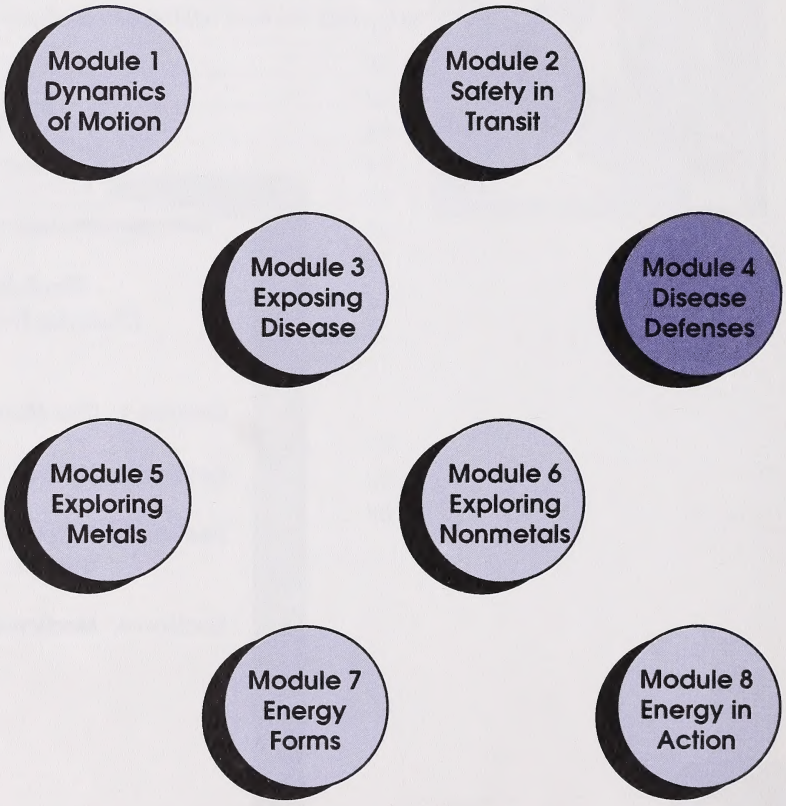


Evaluation

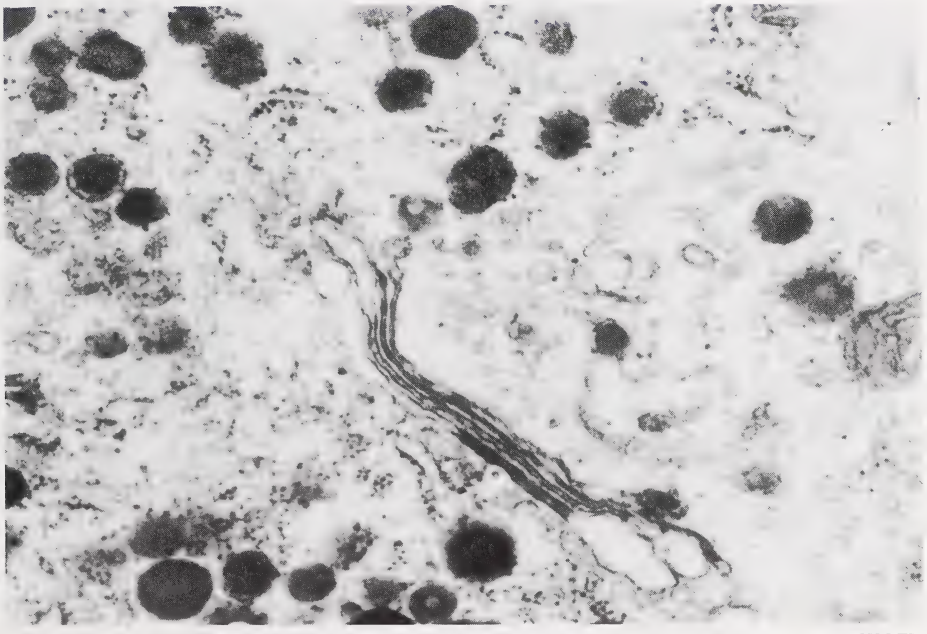
Your mark in this module will be determined by your work in the assignment booklet. You must complete all assignments. In this module you are expected to complete four section assignments. The mark distribution is as follows:

Section 1 Assignment	**20 marks**
Section 2 Assignment	**30 marks**
Section 3 Assignment	**32 marks**
Section 4 Assignment	**18 marks**
TOTAL	**100 marks**

Course Overview



1 The Microscope



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microorganism – a very small form of living thing that is invisible to the naked eye

Have you ever used a microscope? It is amazing to think that you can see microorganisms smaller than the head of a pin magnified.

In order to see **microorganisms**, scientists needed an instrument that would make objects appear larger than they really are.

In this section you are going to learn about the discovery and types of microscopes. The light microscope and the electron microscope will be considered.

You will also use a microscope or microslide viewer to observe **microorganisms** and other specimens.

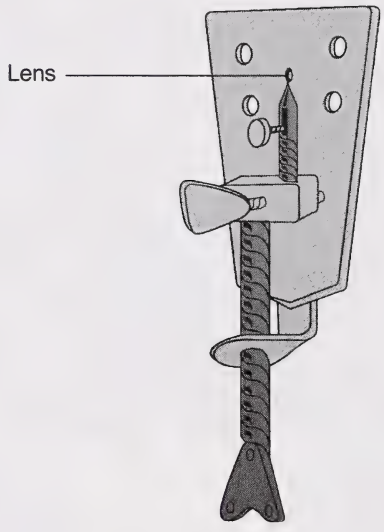
Activity 1: The Microscope and the Invisible World

Do you know who invented the first microscope? How is the modern microscope similar to the first one, and how is it different?

The principle of the microscope was first discovered in 1590 by the Janssen brothers, two Dutch spectacle makers. They accidentally combined two lenses thereby making magnification possible. This arrangement of lenses is the basis of today's compound microscope.

In 1683 Anton van Leewenhoek, a Dutch amateur scientist, made a microscope that could magnify specimens up to 270 times. He also was the first to observe microscopic life and record his observations.

van Leeuwenhoek's Early Microscope



organism – any living thing

Although van Leeuwenhoek's microscope was very crude, it enabled him to observe tiny forms of living things or **organisms**. He called these microscopic organisms animalcules or beasties.

specimen – a part or a whole sample used for analysis or examination

Whenever van Leeuwenhoek found a good **specimen**, he would save it and seal it in his microscope. To look at something else he would have to build a new microscope. He made over 200 microscopes during his lifetime.

Although van Leeuwenhoek was a very skilful lens grinder, he didn't teach his skills to anyone else. It was 200 years before science began to make better microscopes than his.

1. Why did van Leeuwenhoek select the term *animalcule* for the microscopic organisms which he observed in a drop of water?

_____

_____

2. Years later when Louis Pasteur, a French scientist, suggested that little animals in wine caused it to go sour, his idea was highly ridiculed and laughed at. Why?

_____

_____

3. Suggest three uses modern medicine has for the microscope.

_____

_____

_____

4. Give three medical technologies that did not exist in 1950.

_____

_____

_____

5. What does this tell you about the growth of knowledge?

_____

_____

_____

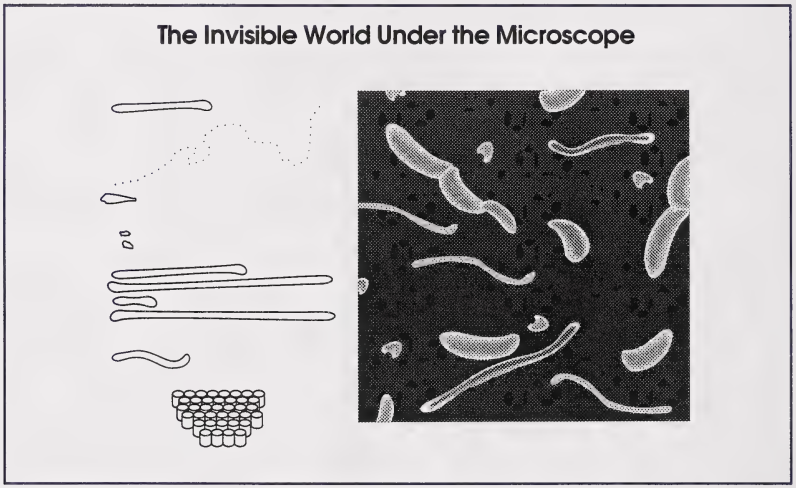
6. How did the discovery of the microscope advance the understanding of disease organisms?

Van Leeuwenhoek studied many different substances under the microscope including blood samples, pond water, and scrapings from between his teeth.

bacteria – a group of microscopic organisms that lack chlorophyll and reproduce rapidly by simple division Harmful types cause disease. Harmless types aid fermentation, decompose waste, and flavour cheese.

He was the first person to observe **bacteria** and record them in a drawing. He said that there were more organisms located in his mouth than there were people in all of Holland.

Observe van Leeuwenhoek's drawings of the organisms which he found in the scrapings from between his teeth.



First drawing of bacteria as seen by Anton van Leeuwenhoek

With the discovery of the microscope, microorganisms were no longer invisible enemies. They could be seen, studied, and dealt with.

7. How did the discovery of mouth bacteria lead to a change in people's personal hygiene?

8. Suggest three common places where disease-causing bacteria may be found.

_____

_____

_____

9. Suggest three ways in which disease-causing bacteria is brought under control.

_____

_____

_____

10. Van Leeuwenhoek was a Dutch merchant whose hobby was to grind lenses. Although he was not a trained scientist, why is he considered one now?

_____

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 1.

Activity 2: Compound Light Microscope

What objects have you viewed through a microscope? Did your samples include tiny forms of living things on temporary slides or permanent slides? What type of specimen lends itself for viewing under the two common microscopes in use today?

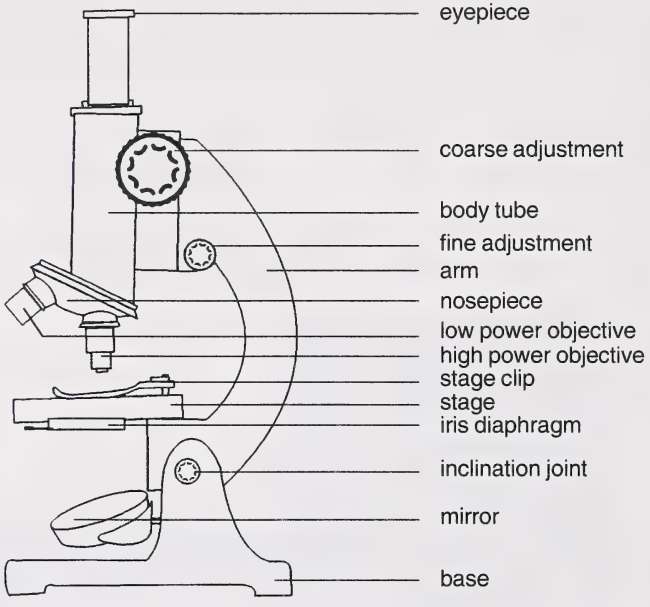
The most common working microscope is the compound light microscope. It uses light and a special arrangement of several lenses in its construction. Another type of microscope uses electrons and electromagnets. You will examine the properties of both microscopes in this section.

resolution – the clearness of an image when magnified

Ordinary light microscopes can only magnify or enlarge objects to a maximum of about 1000 to 1500 times. Beyond this range, **resolution**, or the production of a detailed image, is limited.

The following compound microscope may differ slightly from the one you use to view and study objects.

Compound Light Microscope



Use the illustration of the compound microscope to answer the following questions.

1. Select the labelled parts of the compound microscope to identify the following functions:

   a. reflects light through specimen _____

   b. adjusts the light _____

   c. sharpens image by slight movement of stage _____

   d. connects eyepiece and objective lens _____

   e. raises and lowers stage for focussing _____

f. dims the light _____

g. supports slide or specimen _____

h. supports the microscope _____

i. allows microscope to be carried _____

j. changes magnification _____

2. Using a magnifying glass, look at the letter "a" in this sentence with the glass. About how many times does it magnify the letter?

_____

3. A light microscope can magnify up to 1000 times. How tall would you be if you were magnified 1000 times?

_____

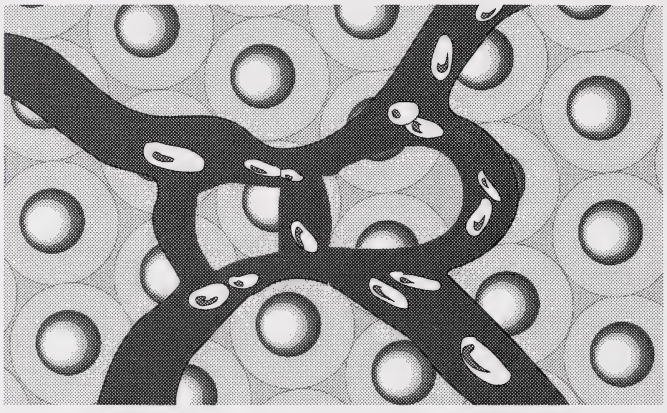
4. The viewing gallery in the AGT tower in Edmonton is 118 m tall. How many times taller would you be than the AGT tower if you were magnified 1000 times?

_____

5. Draw a bar graph to compare your actual size with that of the AGT tower.

The following illustration shows red blood cells, magnified 1200 times, flowing through the capillaries which are the body's tiniest blood vessels. When you look at a drop of blood there are thousands of red blood cells. Imagine how tiny these red blood cells must be.

Red Blood Cells Flowing Through Capillaries



Investigation: Observing Prepared Slides

If you have access to a compound microscope, you can do Part A.

If you have access to a microslide viewer and prepared slide set 58, you can do Part B.

Part A

In this investigation you will use prepared slides or prepare your own slides and view them through a compound microscope. You will sketch the specimens you observe.

Materials You Need

- compound microscope
- prepared slides
- microscope slides and cover slips
- eye dropper
- tweezers
- scissors
- sample specimens which could include
  - hair
  - piece of fingernail
  - newspaper
  - tissue paper
  - cloth
  - pond water
  - onion
  - plant leafs

Steps to Follow

STEP A

If you have access to prepared slides, select four of them. If you don't have prepared slides, make your own wet mounts of any four specimens listed in the materials.

STEP B	OBSERVATION
View the first slide you selected through the microscope.	Specimen Observed: _____ Make a sketch of what you saw.

STEP C	OBSERVATION
Observe the second slide you selected through the microscope.	Specimen Observed: _____ Make a sketch of what you saw.

STEP D	OBSERVATION
Observe the third slide you selected through the microscope.	Specimen Observed: _____ Make a sketch of what you saw.

STEP E	OBSERVATION
Observe the fourth slide you selected through the microscope.	Specimen Observed: _____ Make a sketch of what you saw.

Conclusion

6. Why were you asked to make careful sketches of your specimen?

_____

_____

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 2.

Part B

In this investigation you will use a microslide viewer to view the prepared slide set 58. You will sketch some of the specimens observed.

Materials You Need

- microslide viewer
- prepared slide set 58 which includes
  - cork (300×)
  - onion skin (200×)
  - green leaf (300×)
  - cheek cells (900×)
  - blood cells (900×)
  - nerve cells (300×)
  - bacteria (1500×)
  - virus (50 000×)

Steps to Follow

STEP A

Select any four specimens from the prepared slides, and view them through the microslide viewer.

STEP B	OBSERVATION
View your first specimen through the microslide viewer.	Specimen Observed: _____ Make a sketch of what you saw.

STEP C	OBSERVATION
View the second specimen through the microslide viewer.	Specimen Observed: _____ Make a sketch of what you saw.

STEP D	OBSERVATION
View the third specimen through the microslide viewer.	Specimen Observed: _____ Make a sketch of what you saw.

STEP E	OBSERVATION
View your fourth specimen through the microslide viewer.	Specimen Observed: _____ Make a sketch of what you saw.

Conclusion

7. Suggest a reason why scientists make detailed sketches of what they observe under a microscope.

_____

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 2.

8. Scientists in modern laboratories don't make sketches of microscope views. How do they record their observations of views through a microscope?

_____

_____

_____

9. Microscopes are a very useful scientific tool, especially in medicine. Do you think a microscope is usually used to determine what disease a patient might have? Explain your answer.

_____

_____

_____

_____

_____

_____

10. a. While a light microscope makes things appear much larger, there are a number of difficulties in its use. One difficulty is in obtaining proper specimens to view. Where would you get a live specimen of a paramecium?

_____

_____

_____

_____

b. Why is it difficult to observe live specimens under a microscope?

_____

_____

_____

_____

11. Prepared slides offer some distinct advantages over homemade slides. Why is this?

_____

_____

_____

_____

_____

Activity 3: The Electron Microscope

virus – an extremely tiny particle that is able to reproduce in living tissue and cause disease

The light microscope allows you to see bacteria, but it is not powerful enough to see **viruses**. Bacteria are about 100 times bigger than viruses.

In the 1930s a group of Canadian scientists built the first electron microscope. The group consisted of Albert Prebus, Cecil Hall, Eli Burton, and James Hiller.

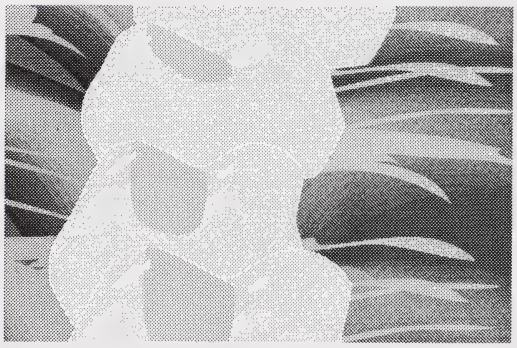
Instead of using light, an electron microscope uses a beam of electrons. The image is projected onto a photographic plate or screen. So instead of looking directly at the specimens, you look at pictures of the specimens. An electron microscope can magnify up to 1 000 000 times compared to 1 000 times for a light microscope.

Can you imagine how big you would be if you were magnified a million times?

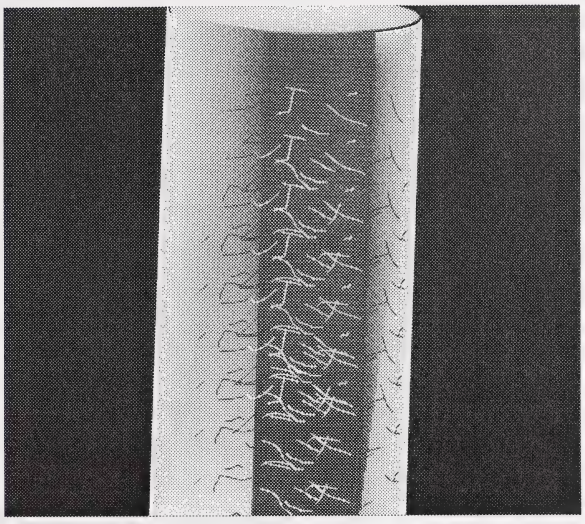
Then try to imagine something a million times smaller than the period at the end of this sentence.

The following illustrations show the magnified images of certain objects. Observe each illustration and try to determine what is being represented.

Is This a Martian Landscape?

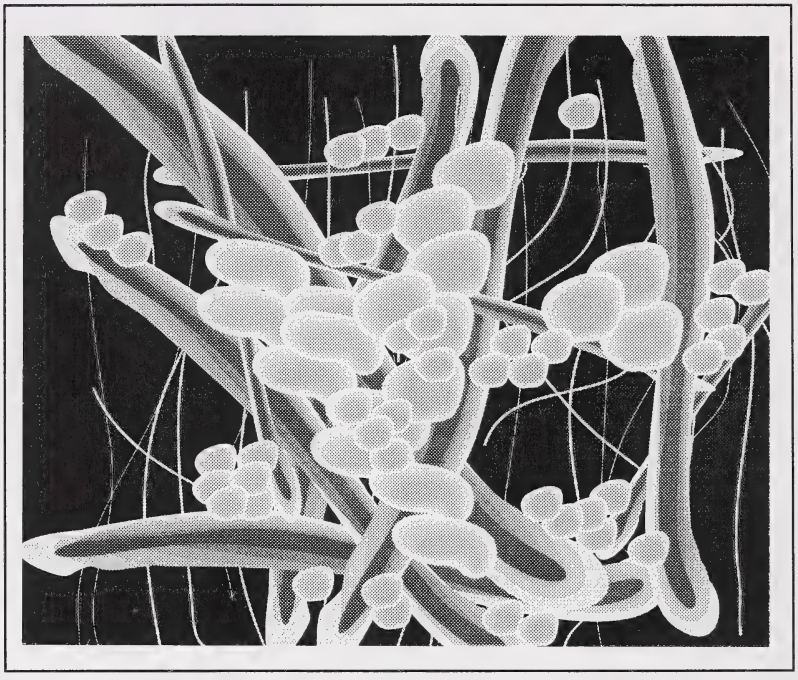


Is This a Palm Tree?



The first illustration is not a Martian landscape, but it is the surface of a tooth where bacteria easily forms. The second illustration is not a palm tree. It is a human hair. In both illustrations, the objects are magnified 100 times.

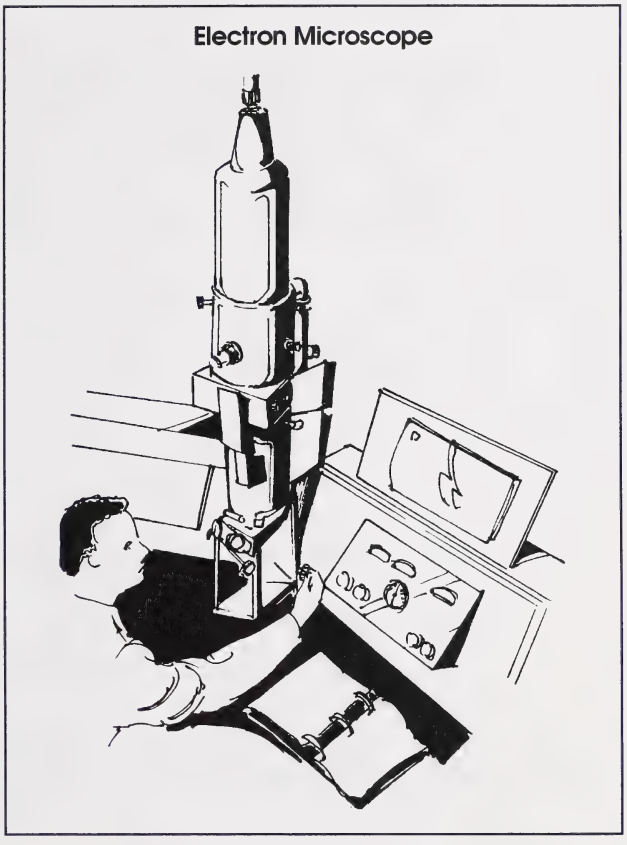
The following illustration shows collected bacteria, known as plaque, on the surface of a tooth under high magnification. Plaque is responsible for tooth decay.



The light microscope opened the door to seeing bacteria. The electron microscope allows the internal structures of bacteria, cells, and viruses to be seen and studied. Scientists are now able to observe extremely small objects with magnifications of 100 000 times or more.

A beam of electrons inside the electron microscope is focussed by an electromagnet onto the specimen. In the transmission microscope, the beam of electrons passes through the specimen. The electrons strike a phosphorous screen which produces an image in much the same way a television produces a picture. In the scanning type microscope, the electron beam strikes the specimen and causes electrons to be generated from the specimen. These electrons strike a sensitive film and produce the well-known three-dimensional effect.

The following illustration shows an electron microscope in use in a hospital.



1. Suggest why an electron microscope would likely be found in a large hospital?

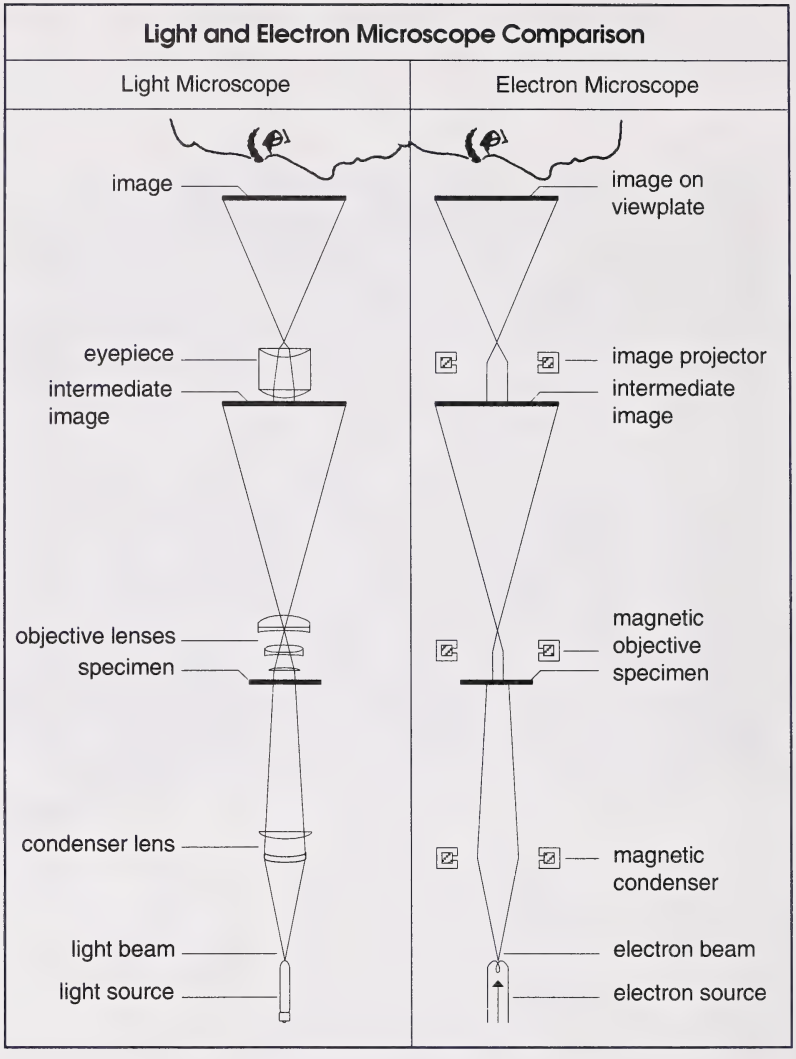
_____

_____

2. Suggest why an electron microscope would likely not be found in a high school?

_____

_____



3. Describe two main differences between a light microscope and an electron microscope.

4. What system is used to focus light in the light microscope?

_____

5. What system is used to focus electrons in the electron microscope?

_____

6. What is the energy source in the electron microscope?

_____

7. How is the image received in the electron microscope?

_____

_____

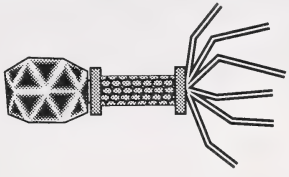
8. How is the image received in the light microscope?

_____

_____

9. Measure the length of the following virus in millimetres, and divide this number by the magnification to obtain the actual size of the virus. Show your calculations.

Bacteriophage (40 000×)



When using a microscope it is important to use the best magnification possible.

To magnify an eyeball, you could use a magnification of three or four times. To magnify a hair, 10× may be useful. To magnify a virus you would almost need to magnify it a million times, which is only possible with an electron microscope.

Recall that as magnification increases, you lose clarity or resolution of the picture. People who work with microscopes have quite a bit of practice in obtaining the best images, and technology has made some recent improvements in obtaining ultra-high graphic resolution.

10. What is meant by resolution?

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 3.

Follow-up Activities

If you had some difficulty understanding the concepts and the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

To help you master the understanding of the microscope, read the following material thoroughly and complete the questions that follow it.

The Microscope

The light microscope makes microorganisms much larger. It can magnify up to about 1000 times. It gives you a clear image up to that point, but the image becomes blurred when higher magnifications are used.

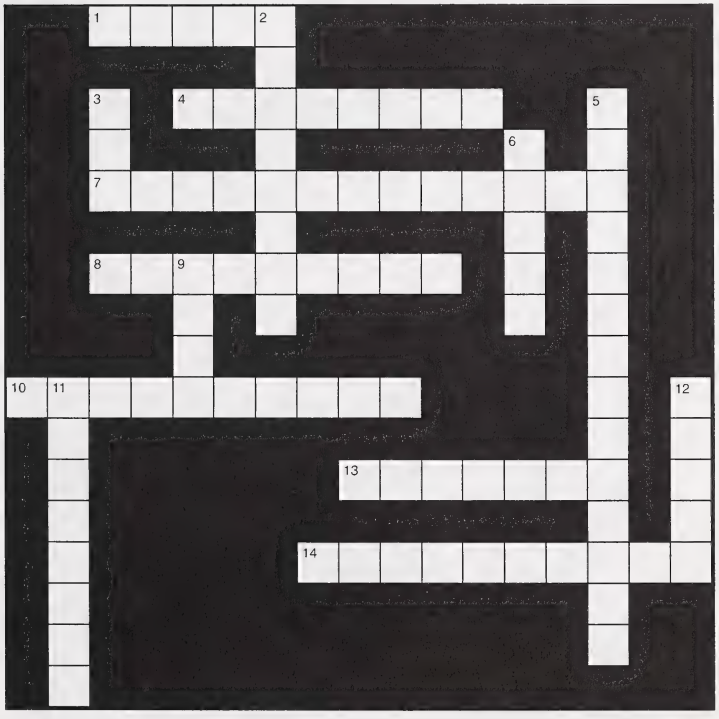
The light microscope allows you to study the cell and even bacteria. To see the small parts of the cell you need an electron microscope.

The electron microscope projects a beam of electrons at a screen or photographic plate. It can produce flat or three-dimensional pictures.

With the electron microscope you can see viruses, which are 1000 times smaller than bacteria.

Using a microscope requires practice. Practice teaches you to use the right magnification so you can see what you are looking for.

Do the following crossword.



Across

1. unseen organism that can only be seen using a light microscope
4. one type of microscope
7. another word for enlargement
8. a type of microorganism
10. clarity in a microscope image
13. number of times an electron microscope magnifies
14. an instrument that enlarges objects

Down

2. what is put on the slide
3. the part of the microscope that you can hold on to for carrying it
5. the man who improved the microscope
6. another type of microscope
9. smallest unit of an organism
11. part of the microscope that you look through
12. what specimens are mounted on

Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

Do **one** of the following.

1. Research and write a report on Anton van Leeuwenhoek.

2. Research and write a report on the properties that makes the electron microscope an improvement over the light microscope limitations.

3. Research and write a report on known diseases caused by viruses.

Check your answers by turning to the Appendix, Section 1: Enrichment.

Conclusion

The discovery of the microscope allows you to see bacteria. An invisible enemy is now visible and can be observed. The electron microscope carries this one step further. Now you can see viruses and small parts of the cell. The microscope is a powerful ally in the fight against disease.

Assignment Booklet

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 1.

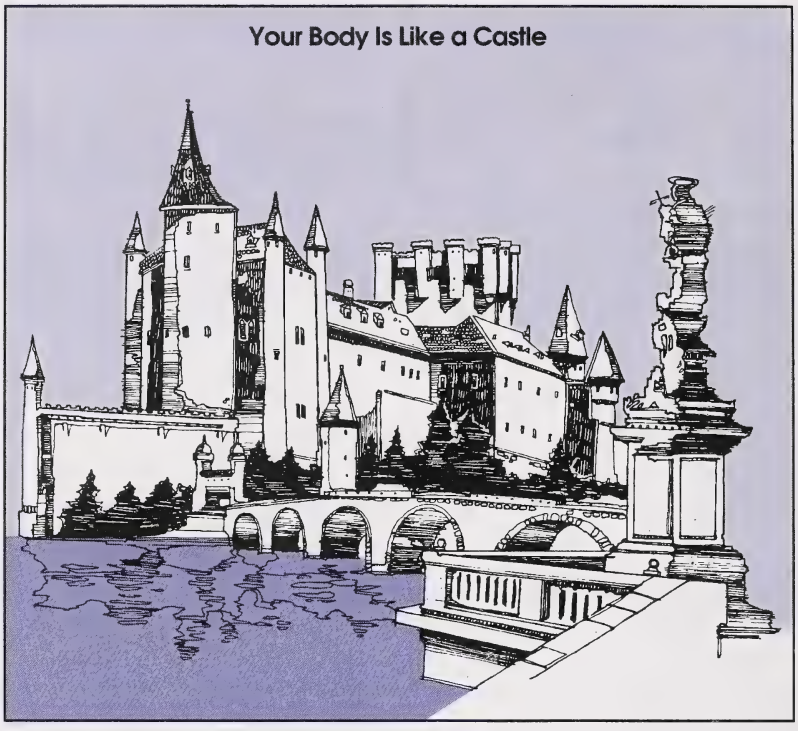
2 Natural Immunity

How often do you catch a flu bug? When did you last visit your doctor or take prescribed medication because of a miserable illness that you couldn't get over? Have you ever been healthy when all other family members were sick?

Why do these disease organisms sometimes cause illness and sometimes have no effect on you?

In this section you will discover ways that your body fights disease, how your body recognizes disease organisms, and what happens when it makes a mistake.

Activity 1: The Body's Defence System



In ancient times castles were built not only for beauty and grandeur. Why were castles built during ancient times? What was their main purpose?

1. Castles were specially built to provide protection and defence from enemy attack. What castle features protected its occupants from invasion?

_____

_____

_____

2. Why did castles sometimes fail to offer protection to their occupants?

_____

_____

_____

Your body is much like a castle. It has two natural defence zones. The first is external and the second is internal. Foreign objects enter through the openings of your body. There are seven places where things from outside your body can invade your body.

3. Name as many of these openings as you can think of.

_____ _____

_____ _____

_____ _____

_____

4. All body openings have a special defence system. How are the following entrances into your body guarded?

   a. nostrils: _____

   b. ears: _____

   c. eyes: _____

   d. skin pores: _____

   e. mouth: _____

5. Make a list of the external defences that your body has to combat disease.

_____ _____

_____ _____

_____ _____

_____ _____

antigen – any substance in the body that stimulates production of antibodies

If an **antigen** gets past your first line of defence, it enters an all-out war zone. Your body has billions of little soldiers whose job is to seek out and destroy antigens.

If your defences find an antigen, they attack and continue fighting until one side or the other is totally defeated. If you win, you don't get sick or you get better. If you lose, you get sick and may die.

6. List four antigens or disease-causing organisms that can enter or invade your body.

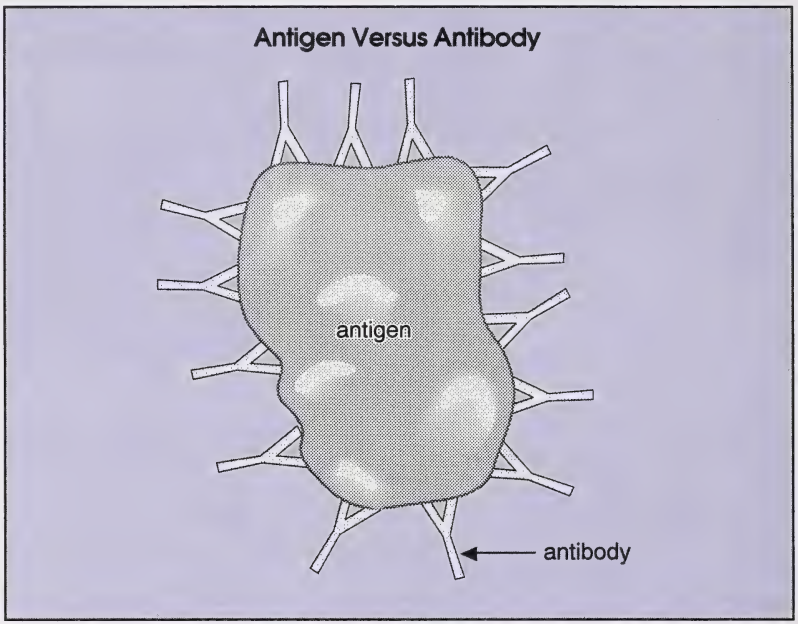
_____ _____

_____ _____

The army in your body is made of many different types of cells. Two general types will be considered.

antibody – a blood protein produced by the body to neutralize an antigen

The first group of defenders are called **antibodies**. They are produced by certain white blood cells. Notice the size of the antigen compared to the antibody in the following illustration.



Antibodies are the first organisms to recognize the non-self particles, the antigens. They attach themselves to the antigen and neutralize it.

phagocyte – a cell eater that destroys foreign particles in blood or tissue

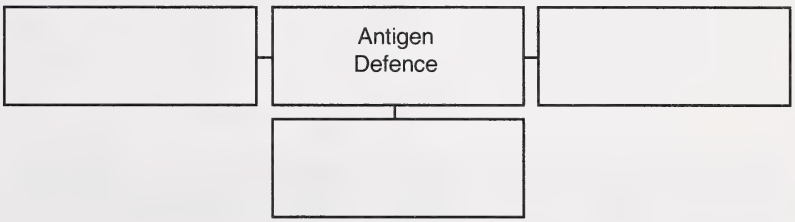
A second defence is the white blood cells. There are many types of these. They can generally be called **phagocytes**.

Phagocytes destroy antigens by two basic methods – ingestion and adherence. Some antigens are easily ingested by a phagocyte. These antigens are engulfed by the phagocyte and destroyed by simple digestion. There are some antigens which must be first coated with special chemicals, such as antibodies, so that they may be ingested. Some antigens are very difficult to ingest even with special chemicals. These types must be first glued by chemicals to another body or trapped against a rough surface like a blood clot or connective tissue. Once the antigen is prevented from moving, it can then be engulfed by the phagocyte.

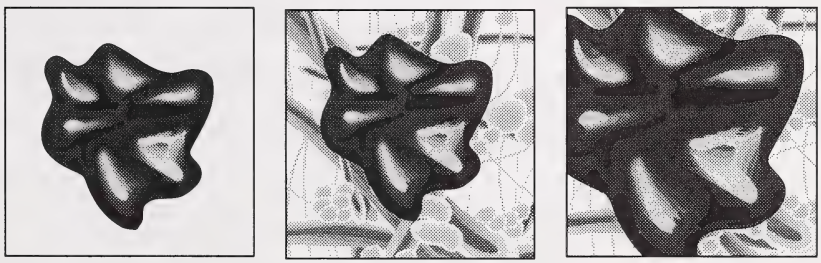
macrophage – a large, wandering cell that eats antigens

One type of phagocyte is called a **macrophage**. If you get a cut, the macrophage devours all the antigens that get in. When it is finished, it secretes chemicals that destroy the antigens and the macrophage.

7. Record the three types of organisms that defend your body against the antigens that enter your body.



A macrophage in action is shown in the following illustration.

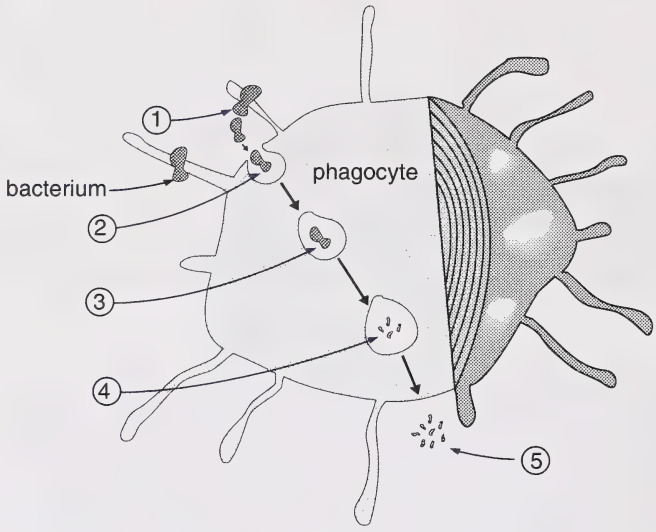


Like a moving mountain, a macrophage devours a colony of bacteria. Although they look awkward, these giant cells are able to engulf invaders very quickly.

phagocytosis – a process in which microorganisms are destroyed by the body

A phagocyte destroys antigens in a process called **phagocytosis** as shown in the following illustration.

A Phagocyte Destroying an Antigen



(1) The cell traps bacteria.
(2) The bacterium is "swallowed" into the body of the phagocyte.
(3) The digestive enzymes begin to attack the bacterium.
(4) The bacterium begins to break apart.
(5) The waste is expelled from the phagocyte.

8. What are the two basic ways in which a phagocyte kills antigens?

_____

_____

_____

_____

Did You Know?

A newborn child begins life by receiving immunity from its mother's milk and whatever antibodies she passes on to her unborn child.

When a baby enters the world, it comes into a very hostile environment. Millions of microorganisms constantly try to attack the baby. The fact that babies survive is remarkable. But how is the baby equipped to fight disease?

placenta – a large, thin structure in the uterus through which a fetus receives nourishment from the mother

The bloodstream of the mother and baby are separated by a barrier called the **placenta**. Blood cells are too large to cross this barrier, but antibodies are not. When the baby is born, it has a whole army of antibodies inherited from its mother.

colostrum – the first fluid produced by the mammary glands following birth

After the baby is born it receives more antibodies. Those that are too large to cross the placenta come from the mother's milk. During the first few days, breast milk is called **colostrum**. It is particularly rich in antibodies.

9. Why do you think that babies who are bottle-fed suffer infections of nose, ear, and throat more often than breast-fed babies do?

_____

_____

_____

Check your answers by turning to the Appendix, Section 2: Activity 1.

Activity 2: Immunity Through Contact

Have you ever had mumps or chicken pox?

communicable – any disease that can be transmitted to others

Once you have had a **communicable** disease, do you worry about getting it again? Did you know that these diseases strike only once because an **immunity** to them is developed. But how does the body do this?

immunity – natural resistance to particular disease or infection due to the presence of antibodies

Earlier you learned about antibodies. Did you know that there is one class of cells that has a memory?

When your body has a disease, certain cells are produced which make the antibodies needed to fight the disease. When the disease is completely destroyed, some of these antibody-producing cells remain in the body. They do not produce antibodies until original antigens come into your body. As soon as original antigens enter your body, the memory cells begin producing antibodies to fight them. They continuously police the body for the antigen of that disease.

active immunity – resistance to disease where antibodies are present to recognize the disease when acquired through vaccination or contact with the disease

So, if you have mumps, your immune system defeats the mumps virus. The cells that fight it die or they fight something else. The memory cells remain to produce antibodies if the mumps virus returns. This is called **active immunity**. You are said now to be immune to the mumps.

Doctors always search for ways to create memory cells in your body without you actually having the disease. Your chances of getting polio or smallpox are negligible if you were immunized against them.

Did You Know?

Although mumps is a fairly mild disease in children, it can be very serious at a later age. When it strikes adolescent or adult men, it can cause painful swelling of the testicles. The swelling could lead to atrophy and sterility.

1. What is immunity?

_____

_____

2. Name two childhood diseases to which you have developed an immunity.

_____

_____

3. What other communicable diseases could you develop an immunity to?

_____ _____

_____ _____

If you become immune to a disease by being exposed to it, why do you get colds more than once?

The answer is due to the fact that there are over 200 viruses that cause the common cold. Immunity is for only one virus. You will not get a cold again from the first virus that infected you. However, you can get a cold from one of the other more than 200 viruses.

4. What other diseases can you get more than once?

_____ _____

_____ _____

Check your answers by turning to the Appendix, Section 2: Activity 2.

Activity 3: Abnormal Immunity

Kathy was given penicillin for a bacterial infection. It cleared up, and a year later she took the same medication. Shortly after, she got hives and then developed difficulty in breathing and collapsed on the floor. She was rushed to the hospital and given medication to open her breathing passages.

allergy – an excessive sensitivity to a specific substance

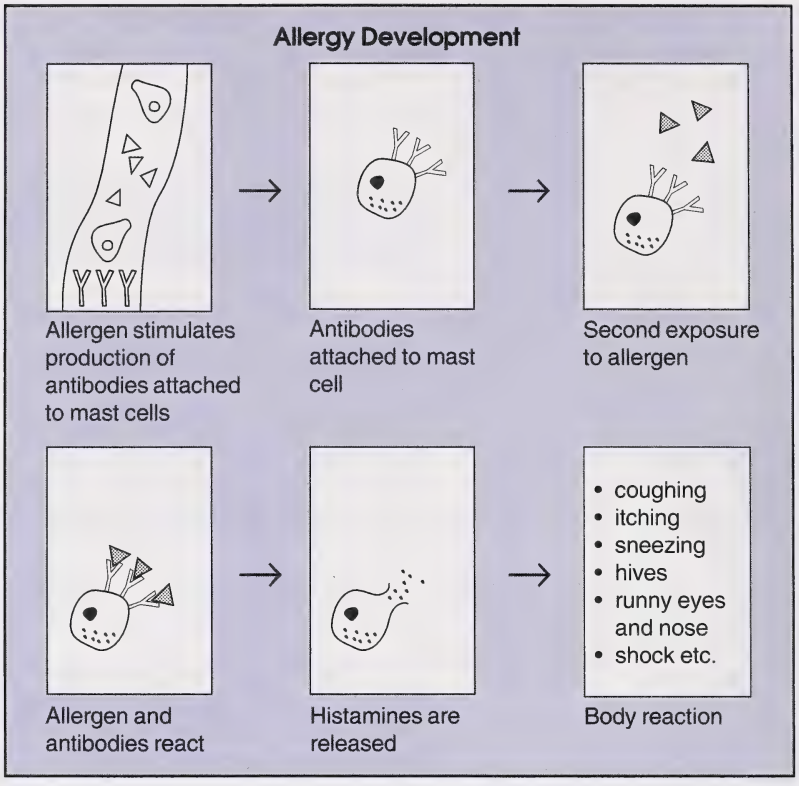
What happened to Kathy? She experienced a severe allergic reaction to penicillin. Here's how a person can develop an **allergy**.

histamine – a substance released during an allergic reaction

When a foreign substance, an antigen, enters your body it is identified as an invader. Antibodies are produced to help destroy the antigen. This system can make mistakes. One type of mistake occurs when the body identifies a harmless chemical (such as a protein in milk) or particle (such as pollen) as an antigen. The body then produces antibodies and memory cells to fight the harmless substance. The antibodies are attached to mast cells which contain an **histamine**. Once the harmless substance is removed, the body has an army of antibodies attached to mast cells ready to fight.

allergen – any substance that produces an allergic reaction

The next time the person is exposed to the allergen, the antibodies react with the **allergen**. This causes the mast cell to rupture and release histamines. The histamines cause allergy symptoms such as sneezing, coughing, itching, runny nose and eyes, rashes, hives, swelling, as well as other symptions. The diagram shows the steps in allergy development.



antihistamine – a drug used to neutralize substances released during allergic reactions

Allergies are often hereditary and there is no cure. If you have allergies, you can use **antihistamines**. Antihistamines are not a cure. They only control the symptoms. To be really effective, antihistamines need to be taken before the allergy attack. These antihistamines bond to the histamines and make them ineffective.

Most people today suffer from one form or another of allergy without realizing it. Do you have any known allergies or know anyone who has an allergy? Allergies may include common things such as pollen, dust, cats, dogs, fruit, nuts, milk, flour products, food additives, cosmetics, insect bites, fibres, penicillin, and many other substances.

There is usually no noticeable reaction the first time you are exposed to an allergen. But your immune system recognizes the presence of the antigen or allergen and produces antibodies. The second time you are exposed to the allergen, you may have an allergic reaction.

Did You Know?

Some people are allergic to common foods, such as peanuts, to such an extent that it becomes life-threatening if they unknowingly consume food containing peanuts or whatever food they are allergic to.

1. Describe what Kathy's body had done between the first and second exposure to penicillin.

_____

_____

2. What would likely happen if Kathy took this type of penicillin again?

_____

_____

3. Why should Kathy wear a medic alert bracelet?

_____

_____

4. What chemical is responsible for the symptoms of allergies?

_____

5. What kind of medication would you take to counteract allergies?

_____

6. When is the best time to take this medication?

_____

Check your answers by turning to the Appendix, Section 2: Activity 3.

Follow-up Activities

If you had some difficulty understanding the concepts and the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

To help you master the concept of natural immunity, match the following terms with their appropriate definitions.

_____	1.	an opening in your body	A. antigen
_____	2.	an external defender	B. macrophage
_____	3.	another name for a white blood cell	C. mumps
_____	4.	a type of antigen	D. virus
_____	5.	a disease-causing organism	E. smoking
_____	6.	a large cell that devours antigens	F. mouth
_____	7.	a communicable disease	G. allergy
_____	8.	causes the common cold	H. tears
_____	9.	an abnormal immune system	I. immunity
_____	10.	weakens your immune system	J. histamine
_____	11.	an allergen	K. anitbody
_____	12.	a chemical that causes allergic reaction	L. colostrum
_____	13.	natural resistance to disease	M. pollen
_____	14.	medication for allergies	N. bacteria
_____	15.	a disease destroying chemical	O. phagocyte
_____	16.	a mother's first milk	P. antihistamine

Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

Do **one** of the following.

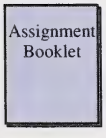
1. If you or someone you know has allergies, write a paper describing the allergy. Describe the allergens, the allergic reactions, and any methods that help control the allergy.

2. Research a childhood disease like mumps, measles, or chickenpox. Describe the symptoms, any mode of prevention, and any secondary effects that could be a problem.

Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

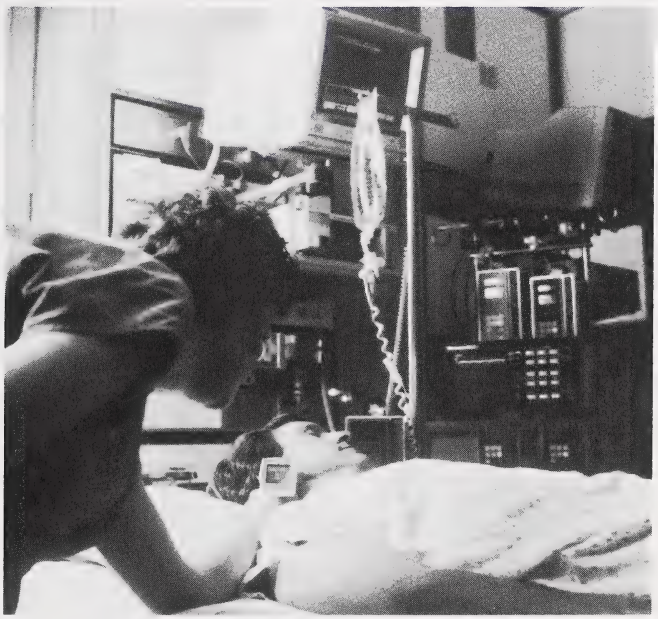
Although your body is surrounded by invisible enemies, they are seldom able to affect you. The reason is that you are equipped with a whole army of microscopic defenders. Learning about your body's immune system allows doctors to support that system and fight disease more effectively.



ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 2.

3 Helping the Immune System



NASA

How does your body's internal army defend you against disease organisms? What happens when your body begins to lose the fight against disease? What army of chemicals has modern medicine developed to assist your immune system?

How does cleanliness keep you healthy? What vaccines prevent diseases? What chemicals kill disease organisms? What are some of the new technologies that will change medicine in the future? In this section you will learn the answers to these questions.

Activity 1: Clean Up Your Act

Can you imagine a doctor coming to examine you with blood on his hands and the clothes on from his last operation?

Would you have any concerns if 60% of the mothers that went into a hospital to have a baby died in that hospital?

autopsy – examination of a body after death

Not too long ago, the mark of a successful surgeon was an apron stained with blood. In some hospitals doctors would perform an **autopsy** in one room and then examine a patient or deliver a baby in the next room. They would not wash or change their clothes. Very often the patients would become sick and die. This is how it was in Europe in the 1700s.

1. What concerns would you have about going to a hospital under these conditions?

   _____

   _____

2. What kind of organisms would be present on the doctor's hands that would cause death?

   _____

   _____

Did You Know?

Early surgery was performed by barbers. The barber could cut off a leg or arm in less than 3 seconds … and do it without any anaesthetic. The symbol used for barbershops today is a white revolving pole with red stripes. Why?

3. Explain why cleanliness is so important in a modern hospital.

_____

_____

_____

4. If you cut yourself, how should you treat your cut?

_____

_____

In society today, many people who are IV drug users sometimes share needles.

5. Explain what diseases IV drug users are more susceptible to from sharing needles. Why?

antiseptic – a substance which destroys infectious bacteria to produce a sterile environment

carbolic acid – a strong antiseptic also known as phenol

aseptic – free from any infectious material

In 1865 Joseph Lister began to operate using an **antiseptic**. He treated a young boy for a **compound fracture**, a leg breakage which people usually died from. He washed the leg and his hands with **carbolic acid**. He continued to cleanse the wound each time that he changed the bandages. The boy lived and Lister's method of using an antiseptic was shown to be useful in preventing secondary infections.

Over the years, in spite of much opposition, Lister's method of **aseptic** surgery became commonplace. If you go to a hospital today, you will find it a very clean place. Doctors wash with great care before surgery. Clean clothes, clean rooms, and antiseptics help to make modern hospitals safer places to treat medical problems.

6. Suggest why Lister received so much opposition to his method of aseptic surgery.

7. Suggest where aseptic methods are commonly practised in a home. How?

8. Why is Lister considered to be a forerunner in the field of modern surgery?

Check your answers by turning to the Appendix, Section 3: Activity 1.

Activity 2: Vaccines

You have received a number of vaccines in your life. Your parents probably were vaccinated against smallpox, yet chances are that you weren't vaccinated for it. What is a vaccine, and how does it work? Why can't you be vaccinated against all disease?

Did You Know?

In the 1700s nearly every person in Europe had smallpox during their lifetime. Over 30 000 000 million people died from the disease. The smallpox virus is now extinct.

Why was smallpox not one of your childhood diseases? How were you protected from it?

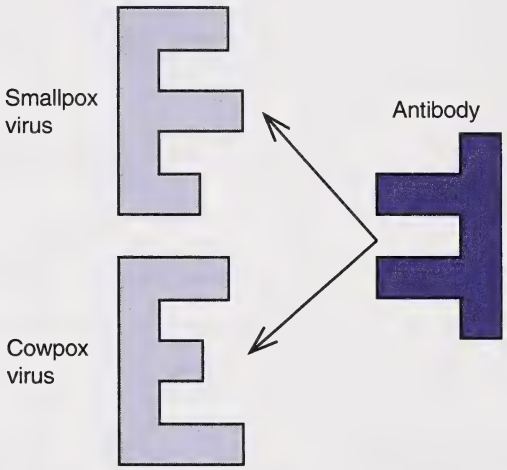
pustules – small pimple-like skin eruptions containing pus

Smallpox formed **pustules** on the face and body. If you survived a smallpox attack, you would have deep and pitted scars that disfigured you for life. Long ago, the Chinese powdered bits of skin from people infected with smallpox and blew it into the nostrils of healthy people. This was to protect them from smallpox.

1. Were people protected against smallpox by the Chinese method? Why?

Despite a lack of background information, Edward Jenner developed a successful vaccine in 1796. He observed that rural townsfolk seemed less susceptible to the deadly smallpox. Jenner began to formulate a hypothesis. He believed that the immunity of the country people must be related to their environment. Jenner noted that dairy maids had a particularly low incidence of smallpox but a high incidence of a much less harmful disease called cowpox. Cowpox produced many of the symptoms of smallpox.

Jenner reasoned that cowpox must have provided some immunity to the more virulent smallpox virus. To test his theory, Jenner injected the pus from a wound on the arm of a diary maid, Sarah Nelms, into a young boy named James Phipps. Not surprisingly, James developed cowpox. However, he recovered from the mild infection very quickly. Two months later Jenner inoculated James with the more virulent smallpox. When James failed to develop smallpox, Jenner declared that a successful vaccine had been developed.



The cowpox virus has a similar shape to the smallpox virus. The antibodies which fit into the cowpox and disable it also fit into the smallpox virus.

Smallpox was such a hated and feared disease that a world-wide vaccination program was started to eliminated the disease. In 1948 the World Health Organization, WHO, an arm of the United Nations, launched a campaign against smallpox. The campaign involved bringing smallpox vaccine all over the world. In May, 1980 WHO announced "The World and all its people had won freedom from smallpox." The last person to get smallpox was Ali Maow Maalin on October 26, 1977. The virus is now extinct except for samples of the virus kept in a laboratory.

2. Why do you think they still keep samples of the virus?

Modern vaccines use a weakened virus to stimulate the production of antibodies. The weakened virus cannot cause the disease. Since colds, the flu, and AIDS are all caused by viruses, why aren't there vaccines against these diseases? The viruses of these diseases change shape through mutation. You are actually immune to the flu you might have had last year. The flu you might get this year is a new strain, and you are not immune to it. The same is true for the common cold and probably AIDS.

3. What is a vaccine?

4. Who was the first person to develop a successful vaccine against smallpox?

5. Why does the cowpox antibody work against smallpox?

6. What three important steps of the scientific method were followed by Jenner?

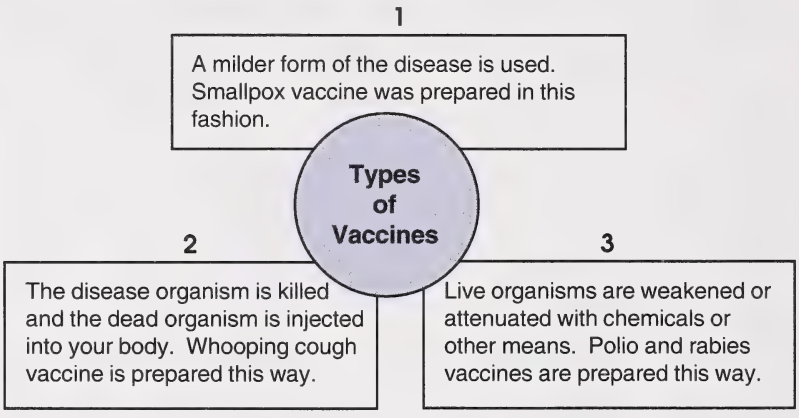
7. What diseases were you vaccinated for during early childhood in either elementary school or a public health centre?

_____

_____

_____

The three types of vaccines are shown in the following illustration.


1
A milder form of the disease is used. Smallpox vaccine was prepared in this fashion.
Types of Vaccines
2
The disease organism is killed and the dead organism is injected into your body. Whooping cough vaccine is prepared this way.
3
Live organisms are weakened or attenuated with chemicals or other means. Polio and rabies vaccines are prepared this way.

These three methods for preparing vaccine have one thing in common. They do not actually attack disease organisms. They merely stimulate the body to produce antibodies against these disease organisms.

8. Describe the three methods for preparing vaccine.

_____

_____

_____

_____

_____

_____

Recall that immunity to a disease can be acquired if you get the disease. For example, if you get mumps as a child, you have antibodies in your system that protect you from getting mumps again.

vaccination – a process of inoculation with vaccine to prevent disease

A **vaccination** makes your body produce antibodies against a particular disease. Your body now becomes immune to the disease.

9. What does a vaccination accomplish?

_____

_____

10. What kind of diseases can be controlled by vaccination?

_____

_____

_____

11. What other diseases like smallpox could be eliminated if all people were immunized?

_____

_____

12. What prevents all people from being immunized?

_____

_____

passive immunity – direct injection of antibodies with a needle last for a short period of time either, through the placenta or colostrum

Another way to create immunity to a disease is to inject antibodies directly. Antibodies are taken from the blood of a human, a horse, an egg of a developing chicken, or some animal and injected in the person. This form of immunity is called **passive immunity**.

hepatitis – infection of the liver due to a virus, drugs, or chemicals

Passive immunity usually lasts for a short period of time. It is useful if you are going on a trip to a country where a disease is common. For example, if you go to a country where **hepatitis** is common you can be protected by being injected with hepatitis antibodies. These antibodies are taken from horse blood and made into a **serum**.

serum – watery animal fluid

The unborn child also receives antibodies from its mother. After birth, the antibodies are received from her milk. This is passive natural immunity. It often lasts for only a few months.

13. What problems could some people develop from being immunized with horse serum?

_____

_____

14. What diseases have been successfully defeated worldwide?

_____

_____

Check your answers by turning to the Appendix, Section 3: Activity 2.

Activity 3: Antibiotics – The Wonder Drugs

Have you ever been asked if you were allergic to penicillin? Were any other **antibiotics** prescribed instead of penicillin to fight off a disease or serious infection?

antibiotic – chemical produced by a microorganism that is able to kill or slow down the growth of another microorganism

Recall that vaccines create immunity to certain diseases. Antibiotics are chemicals that work alongside your immune system to fight against disease organisms.

Case History

When Jeremy was four years old, he was vaccinated in a local health unit. After his shot, he complained about a sore arm. When the pain got worse his parents took him to the doctor. The doctor suggested that the scratch made by the vaccination was infected by a staphylococcus bacterium. Jeremy was given a shot of penicillin and sent home where he quickly recovered. Before the discovery of penicillin, Jeremy's arm might have had to been amputated to save his life. Because of penicillin, Jeremy did not lose his arm to the infection.

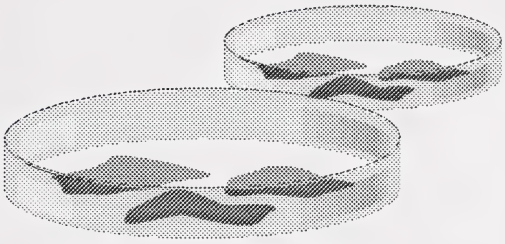
1. Explain why penicillin is considered to be a wonder drug.

_____

_____

culture – food on which a microorganism can grow

Penicillin was accidentally discovered in 1929 by Alexander Fleming. Fleming was growing bacteria on a **culture** plate. He discovered that a mould on the culture killed the bacterium.



Although Fleming's experiment was ruined, he turned his attention to the mould. This mould was penicillium. It was discovered that this mould produced the antibiotic penicillin. It took over ten years before doctors were able to begin to use penicillin to fight disease. Today there are over 80 types of antibiotics that a doctor can use to fight disease.

The use of antibiotics in the fight against disease organisms is not entirely free of problems. There are four problems with using antibiotics.

First, some people are allergic to some forms of antibiotics. If they have an allergic reaction to an antibiotic, the reaction can be severe. Allergic reactions can cause serious illness and, in extreme cases, even death.

2. Why should a person who is allergic to penicillin wear a medical alert bracelet on their wrist?

_____

_____

resistance – ability of the body to oppose disease organisms

Secondly, if all of the penicillin or other antibiotic is not taken as prescribed, you do not kill all of the bacteria. Those bacteria that are left develop a **resistance** against penicillin. These are much harder to kill.

It has been suggested that antibiotics were responsible for producing stronger strains of disease-causing organisms since their use was first introduced. Antibiotics cannot totally destroy all organisms. The survivors become resistant to the drugs and their offspring inherit this resistance as well.

3. Why should a person continue taking antibiotic medication if they no longer feel any disease symptoms?

_____

_____

4. Why are stronger doses of antibiotics prescribed over longer periods of time today than a generation ago?

_____

_____

_____

The second problem relates to the careless use of antibiotics. The person can develop an antibiotic resistant form of the disease, which is very hard to treat. For example, in some Third World countries, penicillin can be bought on the black market. Unscrupulous people dilute the penicillin to make a profit. People using this penicillin are not cured and develop more dangerous forms of the disease. The new bacterial cells may become more resistant to antibiotics.

5. How could careless use of antibiotics or diluted forms of penicillin prove very costly in the end?

_____

_____

The third problem is that antibiotics do not kill viruses. The common cold is caused by a wide range of bacteria and viruses. If your cold is bacterial, penicillin will help you fight the cold. If your cold is viral, the penicillin has no effect.

6. If an antibiotic such as penicillin is not effective against a disease organism, what does this indicate?

_____

_____

7. The word *antibiotic* means "against life." If it destroys or is effective against living disease-causing organisms but not against viruses, does this mean that viruses are non-living? Explain.

_____

_____

_____

The fourth problem is that penicillin does not kill only potentially harmful bacteria but harmless ones as well. There are bacteria in your body that help you fight disease. These bacteria are also killed by antibiotics. It is wise to limit your use to antibiotics and to use them exactly as the doctor prescribed them.

8. State the four problems associated with the use of antibiotics like penicillin.

_____

_____

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Check your answers by turning to the Appendix, Section 3: Activity 3.

Activity 4: A New Frontier

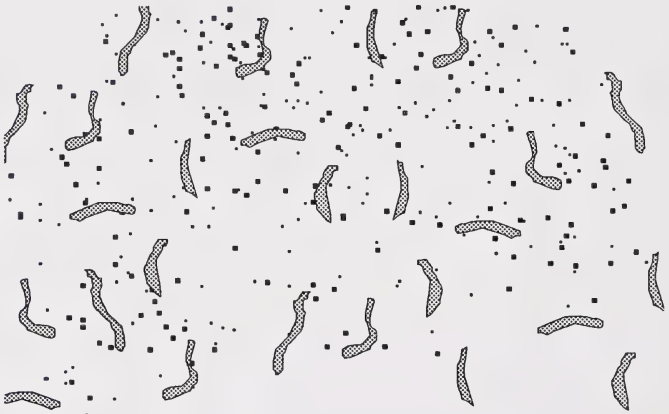
Disease-causing organisms or their toxic wastes attack the host at the cellular level. Disease symptoms tend to manifest themselves as more and more cells are affected.

Since disease occurs at the cell level, it is reasonable to fight it at the cell level. Scientists are now using the machinery of the cell to create new ways of fighting disease.

chromosome – one of forty-six paired microscopic rod-shaped bodies found in nucleus of human cells which carry genes

The **nucleus** of the cell is the master control centre of the cell. It can be compared to the yolk of an egg. There are **chromosomes** in the nucleus. You have twenty-three pairs of chromosomes in every cell of your body except those responsible for reproduction.

Human Chromosomes



gene – any of the units on a chromosome that carry hereditary information

Each chromosomes is like a long thread. Scientists have divided this thread into segments or units of length called **genes**.

Genes on a Chromosome

1. Explain what a chromosome is and what it looks like.

_____

_____

_____

_____

2. What is the total number of chromosomes that you have in the cells of your body?

_____

genetic – dealing with heredity and variation in plants and animals

Since 1973, scientists have been able to splice genes. In **genetic** engineering, also called gene splicing, biologists take a gene segment from a human chromosome and put it in the bacterial chromosome. The chromosome is then returned to the bacterial cell.

The new chromosome now contains a gene segment containing new special genetic instructions. Using gene splicing, the geneticist selects the desired genetic feature, identifies the specific gene that codes for that feature, and splices it into a bacterial chromosome. The bacteria will then carry out the gene instruction.

3. Explain the function of genes in a chromosome.

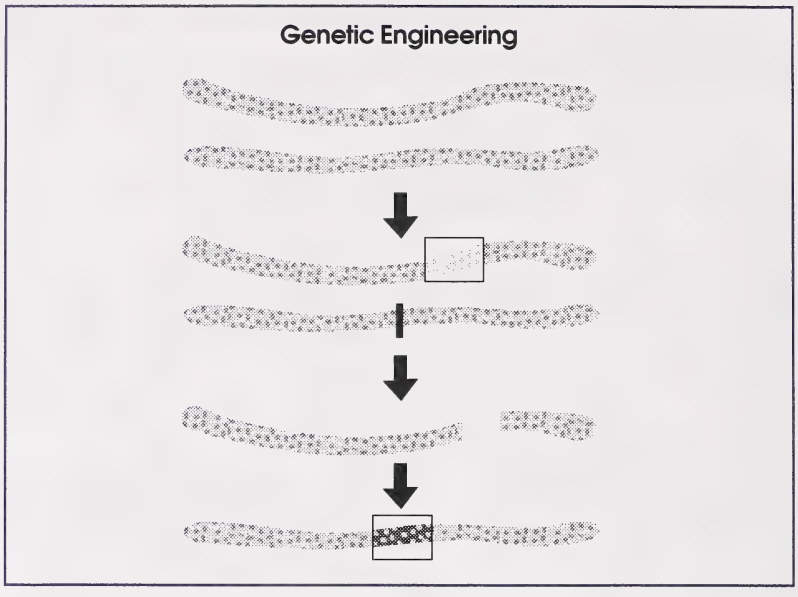
_____

_____

_____

_____

The following illustration shows the process of gene splicing, where two chromosomes are used. One is human; the other is from a bacterium.



4. In what way is the new chromosome similar to the original during gene splicing?

_____

_____

5. In what way is the new chromosome different from the original during gene splicing?

_____

_____

6. Describe how the process of gene splicing could help fight disease.

_____

_____

_____

7. What dangers exist in carrying out gene splicing?

_____

_____

_____

insulin – hormone produced by the pancreas needed by the body to change sugar and starch

Gene splicing was actually used by scientists to develop a bacterium that is able to produce human **insulin**.

Before gene splicing was developed, the only source of insulin was the pancreas in pigs and cattle. Now actual human insulin can be manufactured in a laboratory by these bacteria.

8. Who discovered insulin?

_____

9. What is the function of insulin in humans?

_____

_____

10. Insulin is normally made by the human pancreas. When the pancreas is impaired, an outside source must be found. Explain.

_____

_____

11. Why would some biologists die from microorganisms developed in their laboratory when antibiotics exist?

_____

_____

Have any other materials been produced by scientists using gene splicing?

hormone – a substance produced in some organ of the body that is carried to another where it takes effect

One material is called human growth **hormone**. Some children's growth is stunted when they have too little of this hormone and they become dwarfs. Normally this hormone is produced by the body. An external source of this hormone used to be the thyroid gland in deceased people. Because there were so few of these glands available, only one in six children who needed the hormone could be treated. This hormone is now produced in adequate quantities by bacteria as a result of gene splicing.

12. What two hormones have been produced by gene-splicing bacteria?

_____

_____

13. What harmful effects could usage of the growth hormone have on a young growing person?

_____

_____

_____

clone – an exact genetic duplicate of a cell or organism

Have you heard about genetic **cloning** recently? Can you imagine having a dozen clones of yourself around?

Cloning occurs when you create an exact genetic copy of something. Cloning is based on the fact that every cell in your body has all the genetic information necessary to make you.

In 1978 a science fiction writer wrote an almost believable book about a wealthy man who, with the help of scientists, had cloned a baby. In 1981 a judge ruled that the book was untrue, but the idea is still thought about.

Actually, cloning is a very old process. Taking a **graft** from a plant is a form of cloning. You could clone a carrot by taking a carrot cell and growing it in coconut milk. You could produce a carrot identical to the one you took the cell from. Frogs and mice have also been cloned.

Cloning of people seems to be much more difficult. It is a topic which many science fiction writers like to write about. They make worlds where all the people are cloned to do a specific job. One group of clones would be typists, another would be management, another would be workers, and so on.

Check your answers by turning to the Appendix, Section 3: Activity 4.

Follow-up Activities

If you had some difficulty understanding the concepts and the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

To help you master the concept of helping the immune system, read the following summary and answer the questions that follow.

- Aseptic technique marked the beginning of modern surgery. Use of antiseptics to destroy microorganisms can prevent the spread of disease.
- Vaccines give a person a mild form of a disease which stimulates the body to produce its own antibodies against the specific disease.
- Antibiotics began with the discovery of penicillin. They are a whole range of chemicals that destroy disease organisms.
- Gene splicing involves inserting useful gene segments into a chromosome of a bacterium so the bacterium will do a special job.
- Cloning involves taking a body cell and developing it into a new and identical organism.

Answer the following true and false questions. Place a T if the statement is true and an F if the statement is false. If the statement is false, rewrite it to make it true.

_____ 1. Hospitals have always been very clean places.

_____

_____ 2. Aseptic technique involves the use of chemicals that kill microorganisms.

_____

_____ 3. Vaccination for smallpox began in England.

_____

_____ 4. Edward Jenner scratched the arm of a small boy with the polio virus.

_____

_____ 5. Vaccine can be prepared by weakening disease organisms with chemicals.

_____

_____ 6. It is possible to vaccinate against polio.

_____

_____ 7. Smallpox is a dreaded disease in the Third World.

_____

_____ 8. Passive immunity is acquired by injecting antibodies.

_____

_____ 9. Edward Jenner discovered penicillin.

_____

_____ 10. Antibiotics kill microorganisms.

_____

_____ 11. Antibiotics can cause serious allergic reactions in some people.

_____

_____ 12. You should take antibiotics until the symptoms are cleared up. Then you can set them aside.

_____

_____ 13. A unit of length on a chromosome is called a gene.

_____

_____ 14. Human insulin can be produced by cloning.

_____

Check your answers by turning to the Appendix, Section 3: Extra Help.

Enrichment

Do **one** of the following.

1. Research and write a report on insulin.
2. Research and write a report on diabetes.
3. Use your imagination and write a short story on what would happen if you could clone yourself.

Check your answers by turning to the Appendix, Section 3: Enrichment.

Conclusion

Vaccines, immunization, antibiotics, technology, biomedical processes, and research have resulted in the control and elimination of many life-threatening diseases, which at one time resulted in large scale fatalities. Increasing scientific knowledge, principles, and improvements have made many of these once-fatal diseases and epidemics into exceptions rather than the rule. Research continues in its battle to overcome cancer, heart disease, and other diseases.

Assignment Booklet

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 3.

4 Medicine Today

Modern Medicine

NASA

How often do newspapers report about new and promising treatments for disease? What are some modern medical technologies that have only been recently discovered?

Hardly a week goes by without newspaper headlines or feature stories about environmental effects on human health. TV and print media frequently report about new findings and developments in medicine.

Prevention of disease through vaccines, food additives, diet, and personal life habits are commonly reported. Rejection of tissue and organ transplants and implants, advances in treatment of heart and other diseases, better crops and stock, effects of amniocentesis and birth control are some examples of other medical breakthrough reminders.

What medical breakthroughs or discoveries have occurred during your lifetime or have been reported by media recently?

Activity 1: Vaccine – A Medical Winner

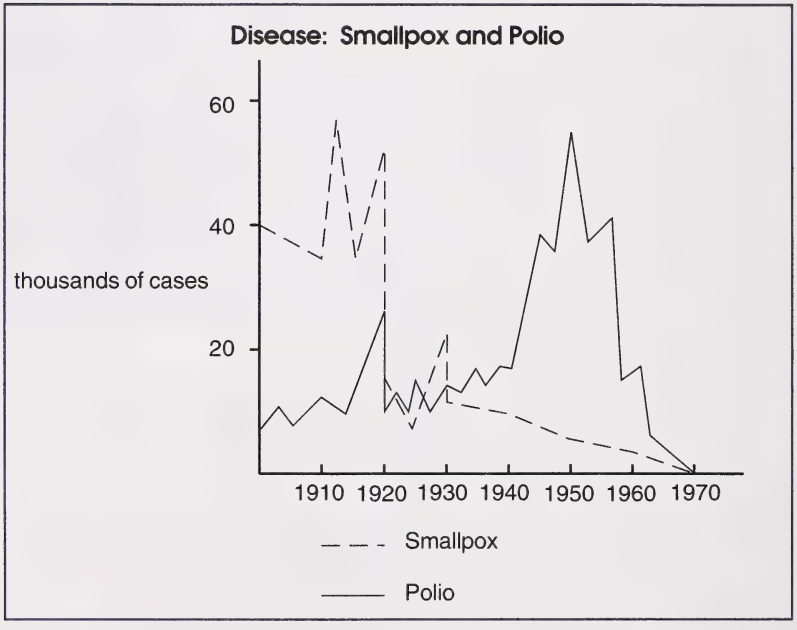
How many people do you know who have polio? How many people do you know who have cancer or heart disease?

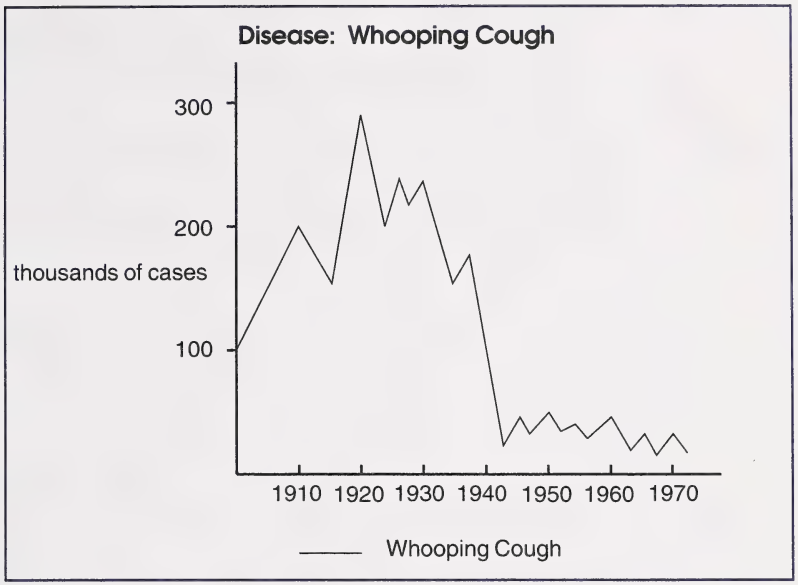
If this question had been asked in 1950, there would have been many known cases of polio. It is probable that you don't know anyone with polio today. Why?

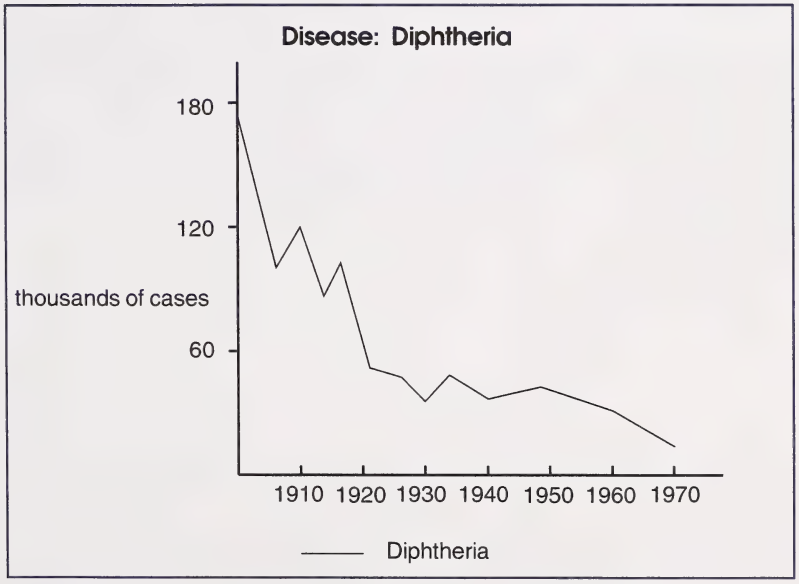
The reason for this change lies in the development of the Salk and Sabin polio vaccines.

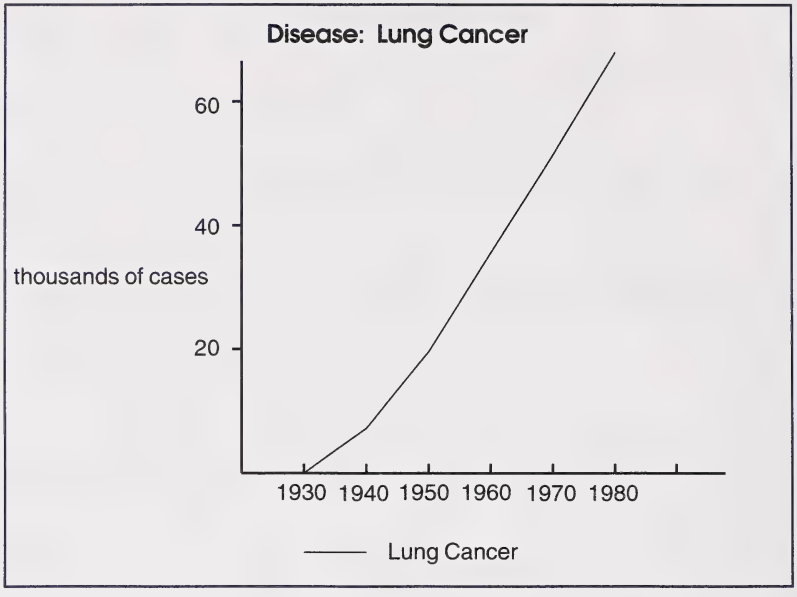
Investigation: Graphical Disease Analysis

In this investigation you will use graphs to interpret and analyse data which show the changes in the number of cases of diseases over a fifty-year period.




Disease: Whooping Cough
300
200
100
thousands of cases
1910 1920 1930 1940 1950 1960 1970
Whooping Cough


Disease: Diphtheria
180
120
60
thousands of cases
1910 1920 1930 1940 1950 1960 1970
Diphtheria



Observations

1. Find the highest number of cases and the year in which smallpox, whooping cough, diptheria, and polio occurred, and organize this data into a table.

Analysis and Interpretation

2. Which disease had the largest number of cases recorded?

_____

3. Which disease recorded the largest number of cases in 1940?

_____

4. Which disease recorded the largest decline in the number of cases from 1920 to 1930?

_____

5. Can you explain why there was a fifty-year decline for the four diseases?

_____

6. According to the graphs, which disease probably does not have a vaccine? Explain.

_____

_____

_____

_____

_____

_____

Conclusions

7. What major factor could explain the decrease in the number of cases for each disease?

_____

_____

8. Why would you consider diseases to be less life-threatening today than if you were a child during the 1920s?

9. Based on the sudden dramatic decrease for the number of cases, estimate the approximate year in which vaccines were introduced for each disease.

10. Using the information from the graphs to support your answer, describe the effect of vaccines on disease.

11. Using the data provided in the graphs, predict what could happen to the four diseases for which there are vaccines?

12. Which of these diseases has been declared no longer active by WHO (World Health Organization)?

_____

_____

13. If a disease has been declared to be no longer active by WHO, does it mean that it is no longer a threat? Explain.

_____

_____

_____

_____

Check your answers by turning to the Appendix, Section 4: Activity 1.

You will notice that vaccines are given for only one disease. The reason is that antibodies only recognize one type of microorganism. Thus an antibody for smallpox has no effect on the polio virus.

In elementary school you received shots for diphtheria, tetanus, measles, mumps, and rubella. These are all communicable diseases. You also received a tuberculosis test and a polio vaccine. In junior high you got a booster shot for diphtheria and tetanus. The reason for this is that the antibodies for these diseases have a short life.

Matthew was exploring an old building site and stepped on a nail. The nail punctured his shoe and went into his foot.

14. Where are the record files kept to find out if Matthew needs a tetanus shot?

_____

Check your answers by turning to the Appendix, Section 4: Activity 1.

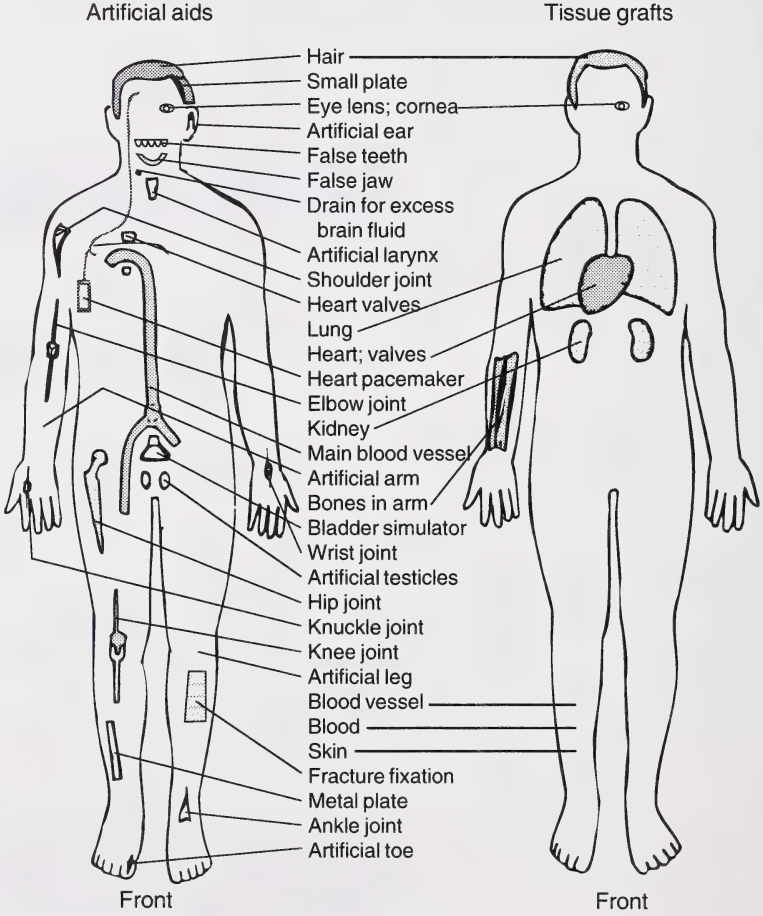
Activity 2: Transplants

Do you know anyone who received a kidney, heart, or cornea **transplant**? How does one become an organ donor?

In South Africa in 1967, Dr. Christian Bernard and a team of doctors conducted the first successful heart transplant. It was a milestone in surgery and even though the patient died, transplants are commonplace today.

transplant – replacement of injured or diseased tissue or organs with natural ones

Transplanted and Implanted Body Parts



implant – the insertion of a tissue or device into some body part

The artificial body in the illustration shows transplants and **implants**. A transplant involves the replacement of an organ with another just like it. An implant is the replacement of part of an organ with an artificial device.

1. a. Using the previous illustration, list six body parts which are transplants.

   Transplants

   _____ _____

   _____ _____

   _____ _____

   b. Using the illustration, list six body parts which are implants.

   Implants

   _____ _____

   _____ _____

   _____ _____

2. Suggest a reason why transplanting bone marrow from a youth to an elderly person might prolong life.

   _____

   _____

rejection – the ability of the immune system to discard a transplant or implant which is foreign to the body

One of the major challenges with organ transplant is **rejection**. Whenever a new organ is placed in your body, your immune system recognizes it as non-self and begins to destroy this foreign body.

3. How does your body reject a foreign object, such as a sliver or thorn, that enters your body?

   _____

   _____

Before transplant surgery, doctors match the tissue type. Then they use chemicals like cyclosporin. Combined with steroids, cyclosporin prevents the production of antibodies that would signal the immune system to attack the transplanted organ. The problem with cyclosporin is that it suppresses other aspects of the immune system. A person treated with it is susceptible to many types of diseases.

Did You Know?

Transplants are very expensive. In 1985, the price of a heart transplant was between $60 000 and $120 000; while a kidney transplant could cost between $25 000 and $35 000.

4. Why are transplant costs probably much higher today than in 1985?

_____

_____

5. The most successful transplant is between people of similar tissue type. What type of people would most likely make the best transplant donors? Why?

_____

_____

One of the most successful transplants and implants involves the eyes. The pupil and iris of the eye is covered by the cornea. If the cornea is severely damaged by accident or disease, the person will have impaired vision, which cannot be corrected by wearing glasses. A cornea from a donor can be very successfully transplanted using laser surgery to restore vision.

cataract – clouding of the eye lens which causes partial or total blindness

As a person gets older, the lens of the eye can become clouded. This condition is known as a **cataract**. The defective lens can be replaced with an artificial lens. The implanted lens often restores vision to normal. Since there is a very limited blood supply to the cornea, rejection of the implant is rare.

6. Why would a small blood supply reduce the chance of tissue rejection?

_____

_____

7. How would a cataract affect vision?

_____

_____

8. Cornea transplants have been very successful in restoring vision. Why are they not available for all people with vision problems?

_____

_____

_____

_____

prosthesis – an artificial device used to replace a missing body part

Many artificial body parts are being used now. Artificial kidneys are not yet available, but artificial limbs, joints, lenses, and hearts are. An artificial limb is called a **prosthesis**. The following illustration shows a prosthesis, in this case an artificial limb replacement. A prosthesis enabled Terry Fox and Steve Fonyo to run across Canada and generate funds for cancer research.

Artificial Limb

9. Why would a prosthesis be periodically replaced even if the parts were not worn out from use?

One very successful implant is the heart pacemaker. It is a small electronic device that gives a regular beat to the heart. This is to correct an irregular heartbeat. The pacemaker is set at a rate of 60 to 70 beats per minute. It works only if an interruption to the patient's heartbeat occurs. Otherwise, it does not interfere with the normal beating heart.

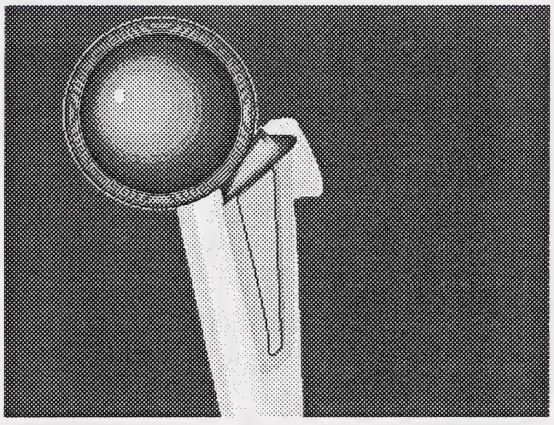
10. Why is a pacemaker called an implant rather than a transplant?

11. Could people who have a pacemaker develop problems during strenuous activity? Explain.

12. What precautions are taken by people with pacemakers?

Many artificial joints are available. The following illustration shows a hip replacement. This prosthesis lasts about ten years because, unlike living cells, it is not able to replace lost or worn out parts.

Artificial Hip Replacement



13. What other body joints have been successfully replaced with a prosthesis?

_____

_____

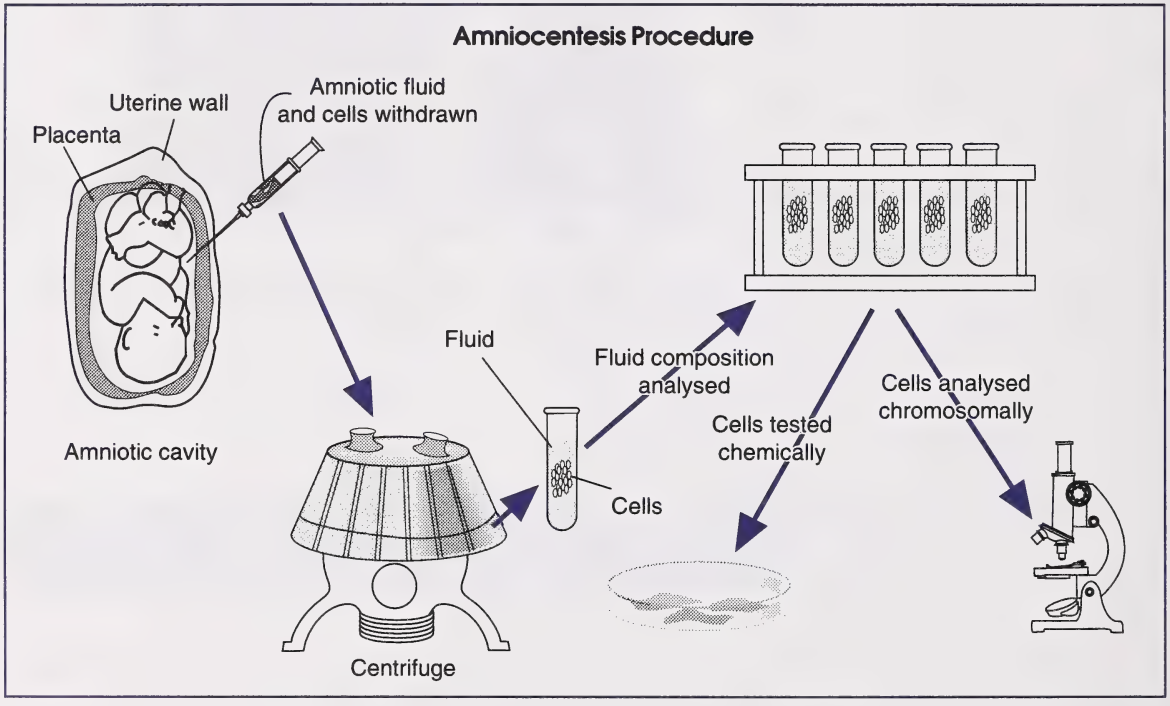
_____

Check your answers by turning to the Appendix, Section 4: Activity 2.

Activity 3: Amniocentesis

Every year thousands of Canadian babies are born with inherited problems. Some people have a greater possibility of inherited problems than others. Doctors can determine many types of problems using **amniocentesis**. The following illustration shows the method of amniocentesis.

amniocentesis – a medical procedure in which fluid is drawn from the sac surrounding the embryo



The doctor uses a syringe to withdraw some of the fluid (called amniotic fluid) that surrounds the fetus. This fluid contains cells shed from the fetus as it develops. Amniocentesis is the study of the cells withdrawn from the fluid. One condition that doctors can detect or test for is Down's Syndrome or mongolism.

Down's Syndrome is an inherited disease which results in mental retardation, abnormal physical features, and weak muscles. The cause is an extra chromosome formed in every cell of the person with the syndrome.

1. Can you think of any way to identify and correct the Down's Syndrome disease?

_____

_____

A number of other inherited diseases can be detected by amniocentesis. They include hemophilia, a disorder that prevents blood from clotting.

2. People with hemophilia can often bleed to death. How could a minor injury or bruise lead to death if there is no evidence of external bleeding?

_____

_____

Duchenne's muscular dystrophy is one inherited disease where muscles appear to be large, but they really are fat tissue. Fabry's disease is another inherited disease which produces kidney failure and leads to death. These and many other diseases can be detected by amniocentesis.

3. Identify one group of people that should consider having amniocentesis done during pregnancy. Why?

_____

_____

4. If a person was in a danger group, why would it help to have amniocentesis done during pregnancy?

_____

_____

Amniocentesis does not cure the disease, it only detects it. The best thing about amniocentesis is that it can help relieve concern during pregnancy. The truth is that amniocentesis usually gives good news rather than bad news.

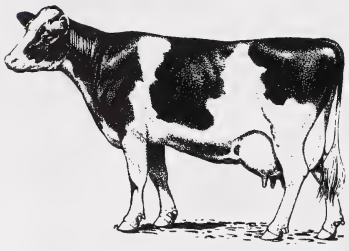
Check your answers by turning to the Appendix, Section 4: Activity 3.

Activity 4: Reproductive Technology

How does a greater understanding of the cell allow science to control cell processes? To what extent can reproduction of plants, animals, and man be controlled?

Biomedical technology can be applied to the reproduction of plants and animals. Consider what happens with cows. One cow is able to produce one calf per year with twins being a rarity.

Selective Cattle Breeding



Imagine that you have a herd of ten cows. One is a purebred exotic breed; nine are ordinary cows. If you could take nine eggs from the purebred cow and implant them in the other cows, you could have ten purebred calves. This is smart farming. Why?

While science can improve animal breeding through embryo transplant technology, it can also alter or improve plants. Many disease-resistant strains of fruits, vegetables, and grains have been or are being developed through a similar technology using gene manipulation or splicing referred to earlier.

1. What is the advantage of removing eggs from a purebred cow and implanting them in an ordinary cow?

   _____

   _____

2. Once purebred calves are born from the ordinary cows, how could the breed be further improved?

   _____

   _____

3. What problems could result from embryo transplants or gene splicing technology?

_____

_____

In 1978 the process of embryo transplant technology was first done with humans in England. The procedure resulted in the world's first test tube baby whose name was Louise Brown.

Louise was not really a test tube baby. In fact she was the result of embryo transplant using sperm from the father and an egg from the mother. These were fertilized and implanted in the mother's womb.

Since Louise Brown was born, embryo transplants have become a fairly common procedure.

4. Why was Louise Brown not really a test tube baby?

_____

_____

5. Why was the embryo transplant technology referred to as a test tube baby?

_____

_____

6. How does embryo transplant technology provide hope to some childless couples?

_____

_____

Some medical advances are very complex. But some of the most effective medical advances are sometimes the simplest.

The HIV virus and AIDS (Acquired Immune Deficiency Syndrome) disease have received wide attention. A very simple technology is able to reduce the spread of AIDS. For example, the use of a condom by males who are sexually active could reduce the spread of AIDS.

The HIV virus is spread by entering an open wound or through body fluids such as semen. A condom prevents the virus from infecting the body.

7. How is the HIV virus that causes AIDS spread?

_____

_____

8. What other measures could reduce the spread of AIDS?

_____

_____

Check your answers by turning to the Appendix, Section 4: Activity 4.

Follow-up Activities

If you had some difficulty understanding the concepts and the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

To help you master the concepts in this section, fill in the blanks for the following statements.

1. Vaccines are used to treat _____ diseases.

2. Three diseases that vaccines have been developed for are _____, _____, and _____.

3. One disease that has been defeated worldwide is _____.

4. As a child you were also given a test for _____.

5. If you step on a rusty nail you could get _____.

6. The first heart transplant was performed by _____.

7. A _____ is the replacement of body parts from one organism to another (usually person to person).

8. When an artificial part of an organ is inserted into a human organ it is called an _____.

9. Many times organ transplants encounter the difficulty of _____.

10. One drug used to reduce rejection is _____.

11. A lens implant in the eye cures a disease called _____.

12. An artificial limb is called a _____.

13. The study of cells withdrawn from the fluid around the embryo is called _____.

14. Amniocentesis is good for detecting _____ disease.

15. New advances in science allow couples who cannot normally conceive to have babies. This procedure is called an _____.

16. The spread of the virus that causes AIDS can be reduced by using a _____.

Check your answers by turning to the Appendix, Section 4: Extra Help.

Enrichment

Do **one** of the following.

1. Many people donate their body organs for transplant. Would you be willing to leave your body parts for transplant? Discuss this question in a short paragraph. Give at least three reasons why you would or would not give your body organs for transplant after your death.

2. Based on the data provided in the graphs and your knowledge of these diseases, sketch a graph for each disease, similar to the ones provided, of what they would probably look like prior to 1900 when no statistical records were kept. Keep in mind that no vaccines existed for these diseases during this time.

Check your answers by turning to the Appendix, Section 4: Enrichment.

Conclusion

Modern medicine has developed an entire army of aids for your immune system. These range from very simple and inexpensive processes to very complicated and expensive procedures. In the end, your immune system can deal with most problems.

Assignment Booklet

ASSIGNMENT

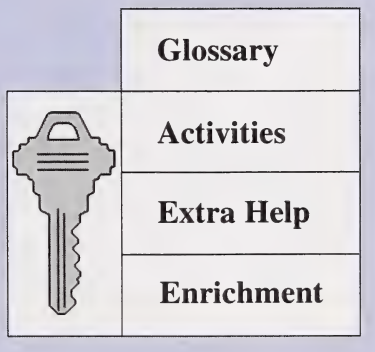
Turn to your Assignment Booklet and do the assignment for Section 4.

MODULE SUMMARY

In this module you have furthered your knowledge about communicable diseases. You have learned that your own body contains a complex army of disease defenders. You should know that your lifestyle can help or hinder the work of your immune system.

If your immune system fails to cope, modern medicine has developed many ways to help you fight disease. In this module you have only looked at a few of the methods that doctors use to fight disease. Good health is a life-time project.

Appendix



Glossary

active immunity
- resistance to disease where antibodies are present to recognize the disease when acquired through vaccination or contact with the disease

allergen
- any substance that produces an allergic reaction

allergy
- an excessive sensitivity to a specific substance

antibiotic
- chemical produced by a microorganism that is able to kill or slow down the growth of another

antibody
- a blood protein produced by the body to neutralize an antigen

antigen
- any substance in the body that stimulates production of antibodies

antihistamine
- a drug used to neutralize substances released during allergic reactions

antiseptic
- a substance which destroys infectious bacteria to produce a sterile environment

amniocentesis
- a medical procedure in which fluid is drawn from the sac surrounding the embryo

aseptic
- free from any infectious material

autopsy
- examination of a body after death

bacteria
- a group of microscopic organisms that lack chlorophyll and reproduce rapidly by simple division
  Harmful types cause disease. Harmless types aid fermentation, decompose waste, and flavour cheese.

carbolic acid
- a strong antiseptic also known as phenol

cataract
- clouding of the eye lens which causes partial or total blindness

chromosome
- one of forty-six paired microscopic rod-shaped bodies found in nucleus of human cells which carry genes

clone
- an exact genetic duplicate of a cell or organism

colostrum
- the first fluid produced by mammary glands following birth

communicable
- any disease that can be transmitted to others

culture
- food on which a microorganism can grow

gene	• any of the units on a chromosome that carry hereditary information
genetic	• dealing with heredity and variation in plants and animals
hepatitis	• infection of the liver due to a virus, drugs, or chemicals
histamine	• a substance released during an allergic reaction
hormone	• a substance produced in some organ of the body that is carried to another where it takes effect
immunity	• natural resistance to a particular disease or infection due to the presence of antibodies
implant	• the insertion of a tissue or device into some body part
insulin	• hormone produced by the pancreas needed by the body to change sugar and starch
macrophage	• a large, wandering cell that eats antigens
microbe	• a disease-causing microorganism
microorganism	• a very small form of living thing that is invisible to the naked eye
organism	• any living thing
passive immunity	• direct injection of antibodies with a needle The injection lasts a short period of time and is injected through the placenta or colustrum.
phagocyte	• a cell eater that destroys foreign particles in blood or tissue
phagocytosis	• a process in which microorganisms are destroyed by the body
placenta	• a large thin structure in the uterus through which a fetus receives nourishment from the mother
prosthesis	• an artificial device used to replace a missing body part
pustules	• small pimple-like skin eruptions containing pus
rejection	• the ability of the immune system to discard a transplant or implant which is foreign to the body
resistance	• ability of the body to oppose disease organisms

resolution	• the clearness of an image when magnified
serum	• watery animal fluid
specimen	• a part or a whole sample used for analysis or examination
tissue type	• similar or identical tissue
transplant	• replacement of injured or diseased tissue or organs with natural ones
vaccine	• any substance injected into the body to produce immunity to some antigen
vaccination	• a process of inoculation with vaccine to prevent disease
virus	• an extremely tiny particle that is able to reproduce in living tissue and cause disease

Suggested Answers

Section 1: Activity 1

1. Leeuwenhoek probably selected the term *animalcule* for the microscopic organisms which he observed in a drop of water because they were invisible to the naked eye but moved around like land animals.

2. When Louis Pasteur suggested that little animals in wine caused the wine to go sour, his idea was highly ridiculed and laughed at because these little animals were not visible to the naked eye.

3. Answers may vary, but three uses for the microscope by modern medicine could include identifying disease-causing microorganisms, identifying cancer cells, and performing microsurgery under magnification.

4. Answers may vary, but three medical technologies that did not exist in 1950 could include open-heart surgery, organ transplants, microchip-driven artificial limbs, diagnostic use of scanners and computers, laser surgery, test tube babies, mechanical organs, and genetic testing. Some of these technologies were developed during your lifetime.

5. The growth of knowledge shows that learning something based on existing knowledge or on something that has already been discovered is easier to understand than learning about it for the first time.

6. The discovery of the microscope increased the understanding of disease organisms by enabling scientists to see, identify, and discover the properties of these microscopic organisms.

7. The discovery of mouth bacteria changed people's personal hygiene practices through regular brushing, flossing, and cleaning.

8. Answers may vary, but three common places where disease-causing bacteria may be found include uncooked food, food leftovers, food containers and preparation surfaces, kitchen sinks, floors, counter tops, tables, garbage containers, barnyards, and skin.

9. Answers may vary, but three ways in which disease-causing bacteria is brought under control include washing of hands and food preparation surfaces, using heat to cook food, refrigeration of food and food leftovers, and practising general hygiene.

10. Van Leeuwenhoek is considered a scientist because of his many observations and his careful recording of data and methods used in his investigation of specimens.

Section 1: Activity 2

1. a. mirror

   b. diaphragm

c. fine adjustment

d. body tube

e. coarse adjustment

f. iris diaphragm

g. stage

h. base

i. arm

j. objective

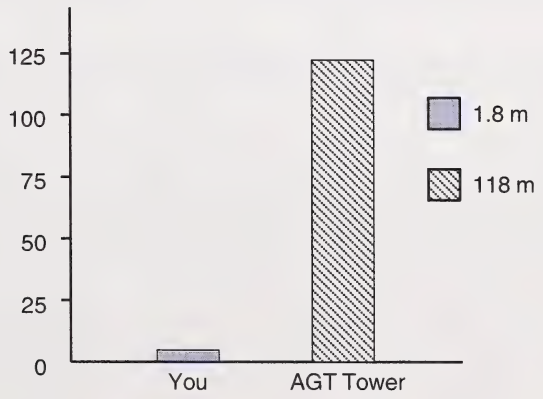
2. The letter "a" should be magnified about four times under a magnifying lens.

3. Answer may vary, but if you were 180 cm tall you would be 1800 m or 1.8 km tall if you were magnified 1000 times.

4. Answers may vary, but if you were 1800 m tall you would be 1800/118 = 15 times taller than the AGT tower if you were magnified 1000 times.

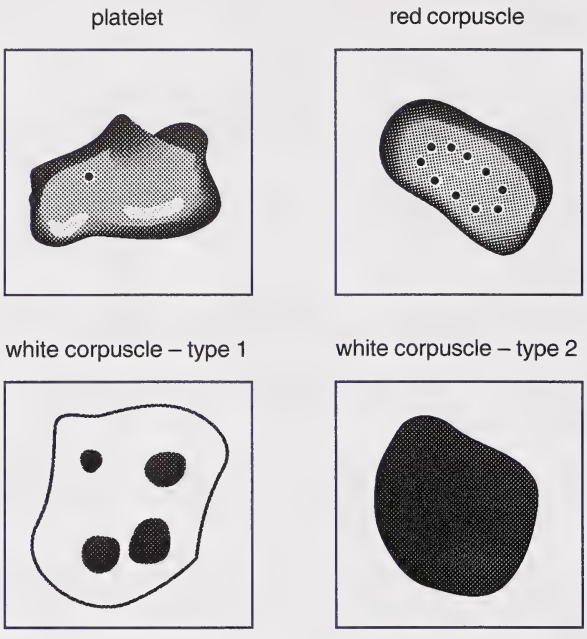
5. Answers may vary, but if you were 180 cm (1.80 m) tall, the bar graph for the AGT tower compared to your actual size would be about 66 times higher (118/1.8). Your graph should be similar to the following:

Title: Comparison of Heights (m)



Investigation: Observing Prepared Slides

Your sketches should represent the components from a human blood smear which you viewed through a microscope or microslide viewer similar to the following outline sketches.



6. A sketch is a permanent record of your observations, and it can be used as evidence. The more important concept is that in order to make a detailed sketch, you have to be much more observant than you are normally.

7. To keep a record and be able to show others their observations, scientists must make careful observations and detailed sketches.

8. Modern scientists take photographs of what they are viewing. By doing this, they get a quick, precise record of what they are viewing.

9. Only in very unusual circumstances are microscopes used to determine a patient's disease. It is very difficult to identify a particular bacterium or virus as being a problem from only viewing a sample. There may be hundreds of foreign bodies in a single sample of human blood or tissue. Specific chemical tests, growth media, and technical analysis prove more accurate and reliable for determining which disease is at work.

10. a. You could find specimens in pond water or possibly in stagnant water. Obtaining these samples in winter time is very difficult. You may be able to order specimens from a scientific catalogue.

b. Live microorganisms move very quickly, and you usually need a chemical to slow them down enough to be able to view them for a reasonable lenth of time.

Often small organisms have clear bodies and must be stained in order to see them. The staining often kills the organism.

11. • A large number of very good quality slides can be made when an optimum set of specimen is collected.

• Highly trained professionals can stain and produce excellent quality slides.

• Certain specimens (bone, muscle, and other normally opaque substances) must be shaved into very thin slices by a special machine before they can be mounted into slides.

Section 1: Activity 3

1. An electron microscope would likely be found in a large hospital for examination of viruses, tissue, and blood samples taken from patients.

2. An electron microscope would not likely be found in a high school due to its size, its high cost, and the training required in using it.

3. A light microscope uses light and lenses, while an electron microscope uses an electron beam and electromagnets. An electron microscope can magnify 200 times or more than a light microscope can. Live specimens cannot be viewed with an electron microscope.

4. The light microscope uses lenses to focus light.

5. The electron microscope uses electromagnets to focus a beam of electrons.

6. The energy source in the electron microscope are electrons.

7. The image in the electron microscope is often received on a view plate or large screen similar to a TV screen.

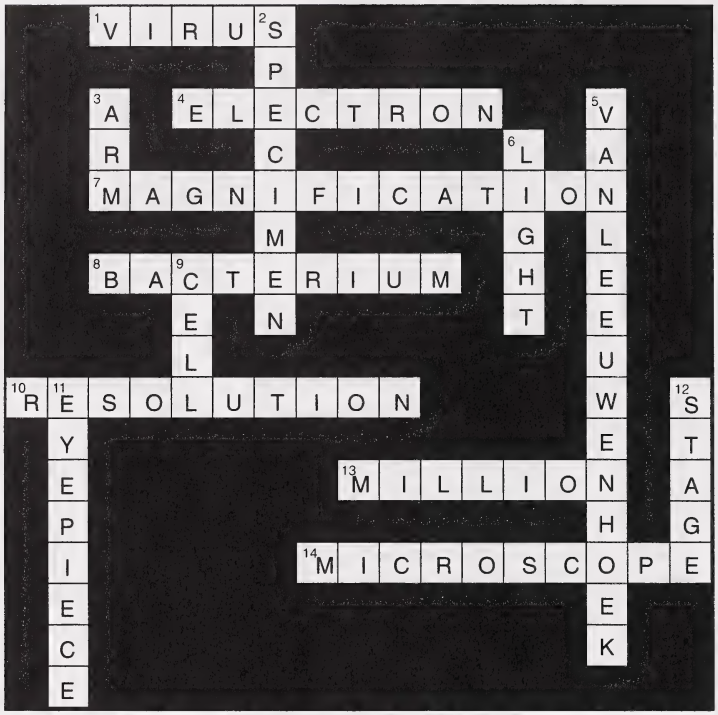
8. The image in the light microscope is received through the eyepiece lens.

9. $\frac{45\ \text{mm}}{40\,000} = 0.001125\ \text{mm}$

10. Resolution refers to the clarity of an image. It is the production of an image under magnification in which details are clearly visible.

Section 1: Follow-up Activities

Extra Help


1 V I R U 2 S
P
3 A 4 E L E C T R O N 5 V
R C 6 L A
7 M A G N I F I C A T I O N
M G L
8 B A 9 C T E R I U M H E
E N T E
L U
10 R 11 E S O L U T I O N W 12 S
Y E T
13 M I L L I O N A
E P H G
14 M I C R O S C O P E
I E
C K
E

Enrichment

1. Your answer will vary, but it could include some of the following facts about Leeuwenhoek:

   - was a skilled lens grinder
   - made lenses about half the diameter of a pea
   - made microscopes that magnified 270 times
   - was the forerunner in study of microorganisms
   - studied head of fly, skin, rainwater drop, scrapings from his teeth, tadpole blood vessels, etc.
   - discovered capillaries and one-celled animals which he called beasties or animalcules
   - made bacteria drawings, confirmed Malpighi's findings
   - exhibited qualities of a scientist by observing, collecting data, and experimenting

2. Your answer will vary, but it could include some of the following features of electron microscopes:

   - uses beam of electrons rather than light
   - magnifies millions of times
   - reveals details of small objects clearly
   - greatly improves resolution of small objects over light microscope
   - electron beam passes through specimen
   - image focussed on fluorescent TV screen or photographic plate by magnetic lenses

3. Answers will vary, but diseases caused by viruses could include

polio	flu	rabies	meningitis
yellow fever	cold sore	shingles	warts
mumps	measles	hepatitis	cold
herpes	malaria	vaccinia	chickenpox
viral pneumonia	viral tumor		

Section 2: Activity 1

1. Some features of a castle that help to protect the castle's occupants from invasion include a moat, fortified structure, few openings, protected entrances, secret passages, and soldiers to defend against attack.

2. Castles sometimes failed to offer protection to their occupants due to enemies, a surprise attack, and a shortage of supplies in the event of a prolonged seige.

3. The body openings include ears, eyes, nostrils, mouth, anus, genital openings, and skin pores.

4. Body opening defenders include

   a. nostrils: mucus and hairs

   b. ears: hairs and wax secretions

   c. eyes: tears, eyebrows, eyelashes, and eyelids

   d. skin pores: several layers, hair

   e. mouth: leads directly to stomach which contains strong acids

5. External defenses that your body has to combat disease include skin, mucus, hair, and tears.

6. Antigens or disease-causing organisms that can enter or invade your body include viruses, bacteria, yeast, fungus, and protists.

7. Three types of organisms that defend your body against the antigens that enter your body include phagocytes, antibodies, and macrophages.

8. Two ways that a phagocyte kills antigens are by devouring the antigen and by adherence.

9. Babies who are bottle-fed suffer infections of nose, ear, and throat more often than breast-fed babies do because they lack the mother's antibodies found in her first milk or colostrum.

Section 2: Activity 2

1. Immunity is a natural resistance to disease.

2. Answers may vary but two childhood diseases that you have probably developed an immunity to could include measles, mumps, or chickenpox.

3. Other communicable diseases that could you develop an immunity to from immunization or direct contact could include smallpox, polio, tetanus, diphtheria, scarlet fever, meningitis, and most other communicable diseases.

4. Bacterial and fungal infections, influenza, and pneumonia are some diseases that you can get more than once.

Section 2: Activity 3

1. Between the first and second usage of penicillin, Kathy's body had produced antibodies and memory cells to fight against the penicillin.

2. If Kathy took this type of penicillin again she would likely have a severe allergic reaction to it and could die.

3. Kathy should wear a medic alert bracelet so she would not be given penicillin in case she is in an accident, unconscious, or unable to speak.

4. The chemicals responsible for the symptoms of allergies are histamines.

5. The medication you would take to counteract allergies is an antihistamine.

6. The best time to take this medication is before you encounter a possible allergy attack.

Section 2: Follow-up Activities

Extra Help

1. F

2. H

3. O

4. D, N
5. A
6. B
7. C
8. D
9. G
10. E
11. M
12. J
13. I
14. P
15. K
16. L

Enrichment

1.
   - Answers will vary but the allergy should be described. The allergy could include allergens such as specific foods, cosmetics, drugs, medications, animals, dust, mold, pollen, plants, feathers, wool, and fabrics to name a few common examples.
   - Allergic reactions may include hives, watery nose and eyes, cold sweat, skin eruptions, wheezing, asthma attack, choking, difficult breathing, heart palpitation, coma, and so on.
   - Methods used to control allergies may include antihistamine medication, allergy serum injections, or antidotes. Severe attacks may require hospitalization.

2. Answers will vary but should include any childhood disease such as mumps, measles, or chickenpox. The known symptoms should be described, as well as methods of prevention and any secondary effects that could be a problem.

   The following describes chickenpox:

   - caused by virus entering through nose and throat
   - spread from person to person through air
   - 2 to 3 week inoculation period
   - starts with mild headache and fever
   - develops into red rash and ends in bumps
   - bump appears like a drop of water on a red base mainly on upper part of body but can occur anywhere
   - bumps dry up to form scales or scabs
   - disease is no longer contagious once the scales form

Section 3: Activity 1

1. Answers may vary, but concerns which you may have about going to a hospital which has unsanitary conditions could include the fear of infection, disease, or unnecessary death.

2. Disease-causing microorganisms would be present on the doctor's hands that would be transferred to the patient and could cause death.

3. Cleanliness is important in a modern hospital to prevent risk of spreading disease from bacteria and other microorganisms. Large numbers of infected patients and the use of antibiotics over time can produce microorganisms which are resistant to most antibiotics. Infections acquired from hospitals are more difficult to treat than to prevent through cleanliness.

4. If you cut yourself, you should clean your cut with clean water and antiseptic.

5. IV drug users are more susceptible to all diseases because disease organisms can be injected directly into the blood stream. Both communicable and noncommunicable diseases are spread between those who share needles.

6. Lister received so much opposition to his method of aseptic surgery because he replaced accepted standards. The mark of a good surgeon, during Lister's time, was a bloodied apron. Blood was not recognized as a disease-transmitting substance. Microorganisms were not understood or visible.

7. Aseptic methods commonly practised in a home include the use of hot water and germicides to clean walls, floors, toilet bowls, kitchen counters, appliances, cookware, and utensils.

8. Lister was considered to be a forerunner in the field of modern surgery because he was the first person to obtain successful results using aseptic surgical methods.

Section 3: Activity 2

1. The Chinese method could have protected people against smallpox if the skin contained smallpox antibodies, but this was rarely successful.

2. Should the smallpox virus still be working somewhere on the planet it is conceivable that another epidemic could occur. The virus is kept to ensure vaccines would be produced and also as a scientific and medical sample. The virus may prove useful in ways not yet foreseen.

3. A vaccine is a substance which stimulates your body to produce the antibodies which are needed to destroy particular disease-causing organisms.

4. Edward Jenner developed the smallpox vaccine in 1796. Actually, some other earlier physicians tried vaccinating by using the pus and skin scrapings from smallpox victims. Sometimes this method worked; sometimes it caused the disease. Jenner's vaccine was safe and reliable.

5. The shape of the cowpox virus and the smallpox virus are so similar that the antibody fits both viruses.

6. Three important steps of the scientific method that were followed by Jenner include

   - recognizing a problem through careful observation
   - developing an hypothesis
   - testing the hypothesis

7. Answers may vary, but the diseases were you vaccinated for during early childhood could include diphtheria, whooping cough, tetanus, measles, mumps, rubella, and polio.

8. Vaccines are prepared by

   - killing the disease organism which can then safely be injected into the body
   - weakening the disease organism which can then safely be injected into the body
   - culture a milder form of the disease which can then safely be injected into the body

9. A vaccination provides immunity against communicable diseases.

10. The kinds of diseases that can be controlled by vaccination are some communicable diseases, usually bacterial or viral diseases.

11. Other diseases that could be eliminated like smallpox if all people were immunized include polio, diphtheria, and measles.

12. What prevents all people from being immunized includes poverty, ignorance, cost, beliefs, and attitude.

13. Some people could develop severe allergic reactions from immunization with horse serum.

14. Smallpox has been successfully defeated worldwide and polio is a close second.

Section 3: Activity 3

1. Penicillin is considered to be a wonder drug because it defeats diseases that at one time killed or maimed vast numbers of people.

2. A person who is allergic to penicillin should wear a medical alert bracelet on their wrist in case of accident or any situation where the person is in an unconscious state and cannot tell medical staff of the allergy.

3. A person should continue taking antibiotic medication if they no longer feel any disease symptoms to kill all the disease-causing organisms.

4. Medical experts have recognized that weak doses of antibiotics over short periods of time were responsible for producing new strains of microorganisms that were resistant to the antibodies. In order to reduce the chances of this happening, stronger doeses of antibiotics are prescribed over longer periods of time in order to completely destroy the microorganism and never give it a chance to produce an antibiotic strain.

5. Careless use of antibiotics or diluted antibiotics can prove very costly in the end due to their inability to fight disease.

6. If an antibiotic such as penicillin is not effective against a disease, it may indicate that the disease is caused by a virus or that the microorganism is resistant to penicillin.

7. Viruses may be non-living material that have a few characteristics of living things.

8. Four problems associated with the use of antibiotics are

    - Some people are allergic to certain antibiotics.
    - Some bacteria become resistant to antibiotics.
    - Antibiotics do not kill viruses.
    - Antibiotics also kill some helpful bacteria.

Section 3: Activity 4

1. A chromosome is a microscopic thread-like structure which carries genes and is found in the nucleus of a cell.

2. The total number of chromosomes that you have is forty-six or twenty-three pairs in every body cell except the cells responsible for reproduction, eggs and sperm, which have twenty-three.

3. The function of genes on a chromosome is to carry hereditary information.

4. A chromosome contains many smaller units of genes over its entire length. During gene splicing only a small unit is added to the new chromosome so that most of it is still similar to the original.

5. The new chromosome is different from the original during gene splicing due to the small unit which has been added to it.

6. The process of gene splicing could help fight disease by developing new antibiotics and other natural chemicals that fight disease.

7. A possible danger to the environment, humans, and other animals exists if a previously unknown strain of the bacterium is produced and proved to cause disease. Until a method of control is developed for this strain of bacteria, there could be widespread illness and loss of life.

8. Insulin was discovered by two Canadians, Dr. Frederick Banting and Dr. Charles Best in 1922.

9. Insulin is a hormone that regulates the body's ability to use glucose sugar. Many people develop or are born with an inability to use glucose. Insulin, a hormone produced by the pancreas helps move glucose into cells for use. Lack of insulin in the blood, causes glucose to be built up in the blood. It is later excreted in the urine.

10. Insulin is obtained from the pancreas of oxen, pigs, or sheep. However, scientists developed a bacterium through gene splicing which also produces insulin.

11. Microorganisms develop a resistance to antibiotics over a period of time. When antibiotics are no longer effective against microorganisms, some biologists die from exposure to resistant strains of laboratory microorganisms.

12. Two hormones that have been produced by bacteria with spliced genes are insulin and human growth hormone.

13. A harmful effect of growth hormone could occur when people use it indiscriminently to become taller.

Section 3: Follow-up Activities

Extra Help

1. F Hospitals only became clean places in the late 1800s.
2. T
3. F Vaccination for smallpox actually began in China and then Turkey before it came to England.
4. F Edward Jenner scratched the arm of a small boy with cowpox virus, then after the boy had cowpox, he scratched the arm with smallpox.
5. T
6. T
7. F Smallpox has been defeated worldwide.
8. T
9. F Alexander Fleming discovered penicillin.
10. T
11. T
12. F Antibiotics need to be completely finished as prescribed by your doctor.
13. T
14. F Human insulin is produced by bacteria that have been altered by gene splicing.

Enrichment

1. Answers will vary depending on the availability and use of resources, but they should include some of the following facts about insulin discovery and its functions:

    - discovered by two Canadian doctors, Banting and Best in 1922
    - first crystalline form prepared by Abel in 1926
    - produced by islands of Langerhans in the pancreas
    - prepared or obtained from pancreas of oxen, sheep, and pigs
    - also prepared by bacteria through gene splicing
    - regulates body's use of sugar
    - lack of insulin or its action results in diabetes
    - insulin injection does not cure diabetes but controls it
    - scientists don't understand how insulin regulates body sugars
    - excessive amounts of insulin results in hypoglycemia, a condition opposite to diabetes
    - different types of insulin preparations differ in how long they last, how fast, or how much is needed for injection

2. Answers will vary, but they could include some of the following facts about diabetes:

   - The body's blood sugar levels are regulated by insulin produced in the pancreas.
   - Not enough or too much insulin can cause diabetes.
   - Diabetics cannot process normal sugar levels resulting in storage or build up of blood sugars.
   - Cause of diabetes is unknown but it may be inherited or a virus could trigger it.
   - Two major types includes juvenile diabetes in children and adult diabetes.
   - Diabetes ranks among the major causes of death in North America.
   - Most diabetics are unaware that they have the disease.
   - Symptoms of diabetes includes excessive urination and thirst, nausea, vomiting, difficulty in breathing, and loss of weight and strength.
   - Complications include blindness, kidney failure, hardening of the arteries, stroke, heart failure, loss of feeling in fingertips and body extremities, and gangrene.

3. Answers will vary, but if you could clone yourself, only your imagination could answer what your expectations would be.

Section 4: Activity 1

1. The table should have a title and columns of organized data similar to the following:

Year of highest disease incidence during 1900s

Disease	Year of highest number of cases	Number of cases in thousands
smallpox	1915	57
whooping cough	1922	295
diphtheria	1900	178
polio	1952	55

2. The disease recording the largest number of cases was whooping cough in 1922 with 295 000 cases.

3. The disease recording the largest number of cases in 1940 was whooping cough with 100 000 cases.

4. The disease recording the largest decline in the number of cases from 1920 to 1930 was smallpox.

5. The development of vaccines and worldwide immunization explains why there was a fifty-year decline for the four diseases.

6. According to the graphs, the disease which probably does not have a vaccine is cancer since the number of cases is increasing while a decrease has been shown for those diseases that have vaccines.

7. One major factor which could explain the decrease in the number of cases for each disease is the existence of vaccines and worldwide immunization against them.

8. One reason why you would consider diseases to be less life threatening today than if you were a child during the 1920s is that vaccines against many of these once life threatening diseases now exist.

9. The approximate year in which vaccines were introduced resulting in a dramatic decrease in the number of thousands of cases for each disease is estimated to be

    - 1920 for smallpox
    - 1940 for whooping cough
    - 1930 for diphtheria
    - 1950 for polio

10. As shown on the graphs, vaccines dramatically decreased the number of cases of reported diseases since they were introduced.

11. The data provided in the graphs indicates that the four diseases for which there are vaccines could become extinct.

12. The disease which has been declared no longer active by WHO is smallpox.

13. Although the smallpox disease has been declared by WHO as no longer active, it does not mean that it is no longer a threat since the microorganism might still exist and could flare up in the future.

14. Record files of previous immunizations are usually kept by the local health unit and family doctor. They could tell if Matthew needs a tetanus shot.

Section 4: Activity 2

1. a. Six body parts that are transplants are

    - heart
    - kidney
    - liver
    - lung
    - cornea
    - bone
    - blood and blood vessels
    - skin

b. The six body parts that are implants are

- hair
- eye lens
- false teeth
- heart valves and pacemaker
- bone joints and plates
- artificial limbs
- fluid drains

2. Bone marrow produces blood cells. Bone marrow in the elderly may not produce many blood cells compared to the bone marrow from a youth. Healthier blood may prolong life in the elderly.

3. When a foreign object, such as a sliver or thorn, enters your body, your body rejects it by attacking it with white blood cells. The result is a pus-filled site.

4. Transplant costs today are probably much higher than in 1985 due to inflation and improved technology which is costly.

5. The best transplant donors are identical twins or close relatives, since their genetic material is more likely similar to the genetic material type of the recipient.

6. A small blood supply reduces the chance of tissue rejection because antibodies and white blood cells travel in the blood and lymph systems.

7. A cataract reduces vision or produces blindness when the transparent lens becomes opaque due to a cloudy formation.

8. Cornea transplants are not available for all people with vision problems as the demand exceeds donors.

9. A prosthesis is periodically replaced as technology constantly improves existing design.

10. A pacemaker is called an implant rather than a transplant because it is an artificial device which replaces the body part.

11. A pacemaker is designed to regulate a normal heartbeat between 60 to 70 beats per minute. Strenuous activity increases the heartbeat which would activate the pacemaker to restore a normal heartbeat. Patients with pacemakers engage in moderate rather than strenuous activity to avoid unnecessary problems.

12. People with pacemakers avoid exposure to microwaves and other forms of radiation which could cause the device to malfunction.

13. Other body joints that have been successfully replaced with a prosthesis include knee and elbow joints.

Section 4: Activity 3

1. The problem could be identified at a very early stage in fetal development but may prove impossible to correct.

2. People with hemophilia can often bleed to death from minor injuries and bruises resulting in internal bleeding which may not be visible externally.

3. Any group of people who have a known family history of inherited disease may consider it wise to have the amniocentesis procedure done.

4. An amniocentesis done during pregnancy could help to relieve the mother's anxiety if she was in a danger group.

Section 4: Activity 4

1. An advantage of removing eggs from a purebred cow and implanting them in inferior cows is to produce purebred calves using ordinary cows.

2. Once purebred calves are born from ordinary cows, the breed could be further improved by repeating the embryo transplant procedure with purebred calves once they reach maturity.

3. A problem that could result from embryo transplants or gene splicing technology is the unknown long range effect or development of other undesired qualities.

4. Louise Brown is not really a test tube baby as her development occurred in her mother's womb rather than a test tube.

5. The embryo transplant technology was referred to as a test tube baby because of fertilization outside the body, probably in a test tube.

6. Embryo transplant technology may help some childless couples have children when normal conception fails.

7. The HIV virus is spread through open sores, sharing of drug needles, blood, and semen.

8. The spread of AIDS could be reduced through avoiding known transmission methods and making decisions on an informed basis.

Section 4: Follow-up Activities

Extra Help

1. communicable

2. rabies, rubella, tetanus, polio, diphtheria, smallpox, or whooping cough

3. smallpox
4. tuberculosis
5. tetanus
6. Dr. Christian Bernard
7. transplant
8. implant
9. rejection
10. cyclosporin
11. cataracts
12. prosthesis
13. amniocentesis
14. inherited
15. embryo transplant
16. condom

Enrichment

1. Answers will vary, but you should adopt a position on the issue of leaving your body parts for transplant. You should include at least three reasons why you would or would not give your body organs for transplant after your death.

2. A sketch of a graph for each disease prior to 1900 would probably include increasing and decreasing numbers of cases similar to those shown for each graph but at a higher level than that shown at the beginning of each graph.

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